

# SCIENTIFIC AMERICAN

## SUPPLEMENT. № 1385

Copyright, 1902, by Munn & Co.

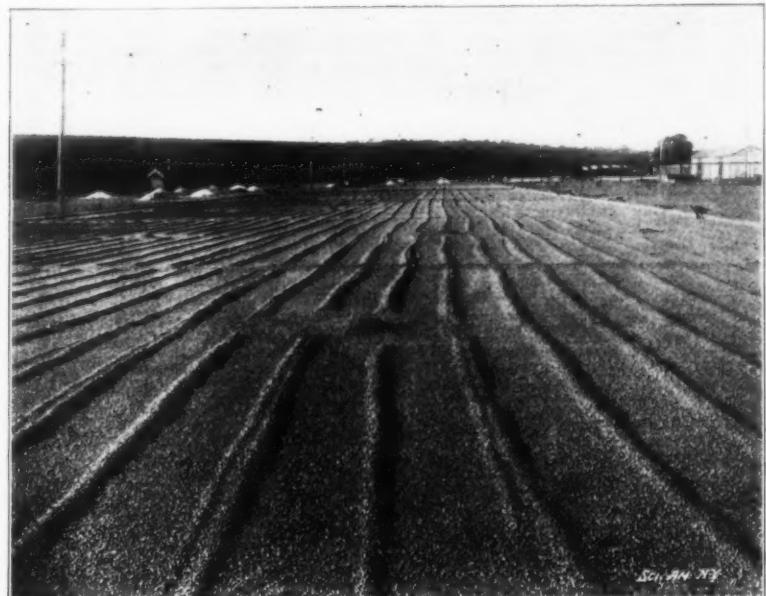
Scientific American, established 1845  
Scientific American Supplement, Vol. LIV. No. 1385

NEW YORK, JULY 19, 1902.

Scientific American Supplement, \$5 a year.  
Scientific American and Supplement, \$7 a year.



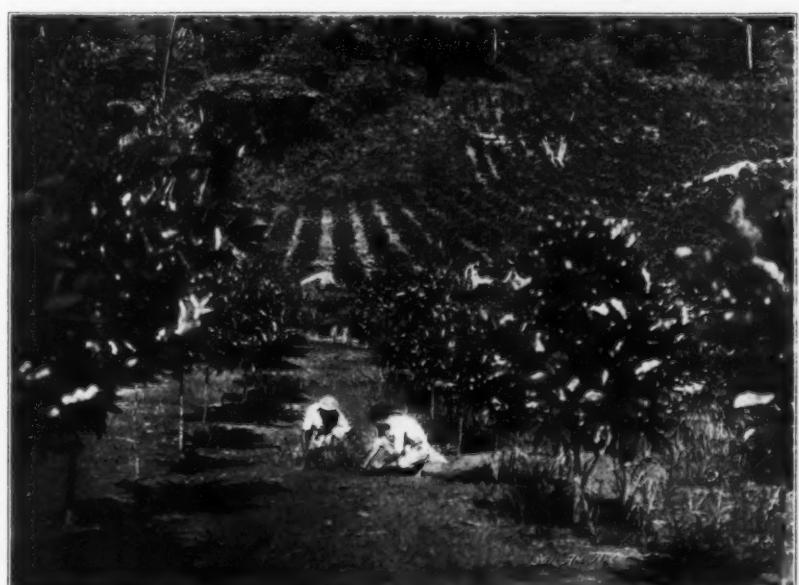
JOLO COFFEE TREE IN SOUTHERN PHILIPPINES.



THE LARGEST DRYING-FIELD IN THE WORLD.



FAZENDA OF TWO YEARS. CLEARING IN FOREGROUND.



A JOLO COFFEE PLANTATION IN SOUTHERN PHILIPPINES.



THE OLD AND NEW RAILROADS IN BRAZIL'S COFFEE REGION.

THE CULTIVATION OF COFFEE.



PICKING COFFEE IN BRAZIL.

## COFFEE.

By E. C. ROST.

On my visits to the world's greatest coffee-producing countries—among them Brazilian, Philippine, Hawaiian, Cuban and Puerto Rican coffee fields—I learned some facts which may be of interest. Little is known of the early history of coffee, though it has been in use for more than 1000 years. Prior to the eighteenth century all the coffee used in Europe was brought from Arabia Felix via the Levant. This trade was broken up when the vessels of England and Holland doubled the Cape of Good Hope. In 1697 Van Horn introduced coffee into Batavia; from there it was taken to France and from there to Martinique and other of the West Indian Islands. In 1754 Fr. Villas, a Franciscan monk, took a plant to Rio Janeiro and cultivated it in the garden of the monastery of St. Anthony. The origin of the name is somewhat obscure; it has been said to come from Kahaw, an Arabic word, but this seems to be somewhat far-fetched, as coffee did not originate in Arabia, and it doubtless had a name when it was brought there. In all probability the word is derived from Kaffa, the name of a province in Abyssinia, where it is found in a wild state. The coffee plant belongs to the genus *Coffea*, order *Rubiaceae*, and is related to the Cape Jasmine, and also to the little spring "Bluet" of our pastures. It was my privilege to study the coffee industry in many parts of the world, but not until traveling through Brazil did I realize the tremendous effect of this article upon the world's commerce.

We know Brazilian coffee in this market as Rio and Santos, and look upon it as an inferior grade. As Rio is the center of the world's coffee supply, I propose to begin from that point; and without giving any description of Rio city or even of the coffee interests there (as it is simply a port of shipment), I purpose to travel from Rio inland to the coffee districts. The great Dom Pedro Railroad, on which are used American cars and locomotives, carries us 310 miles through a section where we see remains only of coffee orchards. A twelve-hour run brings us to Sao Paulo city, the capital of a province or state of like name. Sao Paulo lies upon a great plain with low hills upon the entire horizon. It has a population of more than 250,000 inhabitants, and owes its very existence to the coffee trade, of which it is the center. It is a modern city with wide streets and comfortable houses. It has electric light and trolley cars built in the United States. It is here that the Fazendeiro (plantation owner) lives in the finest of mansions during the winter months. We must travel still further, however, to reach the coffee-growing country. From Sao Paulo many railroads diverge, all practically existing from the coffee-carrying trade.

I left from here over the Paulista road, and my first stopping place was Campinas, a distance of 80 miles, where are seen many large Fazendas (coffee orchards), but not until we travel still further do we see the world's famous ones; so I traveled on by rail to Buenopolis, some 400 miles, in which locality we find the largest Fazendas on the globe, some having about 5,000,000 trees. At Buenopolis I was most royally entertained by the owner of the largest Fazenda hereabout, and after whom the place is named, and here we see naught but straight rows of coffee trees covering the hillsides. We find ourselves on a tableland some 200 feet above the level of the sea, the surface of which presents an undulating appearance. The Fazendeiro lives with his family in a mansion usually more or less in the center of his Fazenda, and on elevated ground, and he therefore has an unobstructed view all around quite to the horizon of coffee trees. These houses are usually surrounded by splendid fruit orchards and flower gardens; in the latter I saw growing side by side pineapples, watermelons, strawberries, orange trees, bananas, and in fact all tropical fruits of South America, as well as many of the temperate zone. These houses are of enormous size, the rooms being very large and often twenty-five feet in height. Such a Fazenda is a world in itself; here are buildings for the different superintendents, a hospital, barns, buildings for the laborers, and, of course, those containing the machinery used in preparing the coffee for the market; surrounding these are the immense drying fields, which in some instances are half a mile in length. In order to give me every facility to study the coffee industry, I was driven by my host in a buckboard mile after mile over his Fazenda. We naturally visited first those parts where trees were being planted, and I found that here coffee trees bear about the fifth year after planting.

It is an evergreen, and generally grows from a single shaft, although in Brazil it is more often seen growing in bunches of six to eight slender trunks. It has a long, smooth and shining dark-green leaf with fragrant white flowers growing in clusters in the axils of the branches. The berries are formed in clusters varying in number from three to twelve, and have either very short stems or none at all. The fruit, when ripe, resembles a medium-sized ripe cranberry in size, shape, and color. Each berry contains two seeds embedded in a yellowish sweetish pulp, and which is delicious to eat when ripe.

Each seed is shaped like an irregular half sphere, so that when the two surfaces are together, they form almost a perfect sphere. The pulp is removed by a pulping process; the thin parchment skin is then taken off and the berry is polished; when this process is completed, we have the coffee of commerce. Sometimes the berry contains only one seed, the other having failed to develop. This seed is almost round, and is known as the peaberry or male berry. Much of the Mocha coffee is of this kind, and the same is found in India and Maramangape regions of Brazil. It is also found to a greater or less extent in all kinds of coffee, just as imperfect or dwarfed cherries or apples are found on the trees with perfect fruit. This peculiar growth of coffee is screened out in the process of cleaning and sold as a separate grade. It is, in fact, what we know nowadays as Mocha coffee. In recent statistics of the coffee trade of Arabia, mention is only made of Aden as the port of shipment, and the available figures show that about a like number

of bags of coffee were imported for re-export as against the number shipped outward. Personally I have seen thousands of bags of coffee shipped from Brazil direct for Aden, the port of shipment for Mocha.

Nowadays there is no genuine Mocha coffee, that is, coffee grown in Yemen or Wady Negram. There is no coffee grown in or near Mocha. When one reads in the market reports the great number of names used to designate the different kinds of coffee he is confused, but he must remember that these names refer to the place from which the berry is shipped, and that the coffee all belongs practically to the same species. But to return to the young coffee trees, I found that holes are dug for the seed or plants as the case may be from eight to twelve feet apart. The holes are covered with bark or chips, making a sort of roof, until the plants are strong enough to stand the hot sun. During the first two years corn or beans may be planted between the rows, and the expense of cleaning is thus reduced to almost nothing by the value of these side crops, which the small farmer cultivates with his regular help hired by the year, but which the large planter loses altogether, as they belong to the men who clean and pick the coffee trees at so much a thousand. This system prevails throughout the Brazilian coffee districts, and enables the Brazilian Fazendeiro to compete most favorably with all other coffee-growing countries. Almost all labor of this nature is performed in this section by Italian immigrants.

The coffee tree measures in height when mature about thirty feet. An average coffee tree in Brazil bears something like five pounds, which, however, varies in some sections here from three to six pounds. When we consider that the average yield in other countries is only a little over one pound per tree, we can see what immense natural advantages Brazil has. The rapid decline of coffee planting in the West Indies, and the total failure in Ceylon and many other parts of the East, leave Brazil with but few strong competitors. Brazil produces more than two-thirds of all the coffee in the world, and in one year produced (during an unusually good crop) six hundred and sixty thousand tons, whereas the world consumed only six hundred thousand tons.

The vast area of inexhaustible red lands of the province of Sao Paulo alone, and immunity from the leaf disease that has destroyed the industry in Ceylon and in many parts of the West Indies, point to Brazil as the greatest coffee-producing country in the world, with which it will be very difficult to enter into competition. The range of latitude is so great that when flowers are coming out in one section the ripe fruit is being gathered in another, so that coffee is sent to market from here all the year round.

It is a singular fact that while English and German capital has been attracted to the coffee industry in Brazil, and large sums have been invested, American capital and enterprise have not seen this fine opening. Coffee planting in Brazil has been the most profitable farming in the world. Coffee can be produced at considerably below the present prices, as has been proved by some of the foreign companies, and even at a larger profit than the western American farmer realizes on his corn at thirty cents or his wheat at eighty cents per bushel.

The unexampled prosperity of the state and city of Sao Paulo is a proof of this. The growth of the coffee industry has increased the city from a college town of twenty thousand inhabitants to a cosmopolitan city of more than two hundred and fifty thousand, and has gridironed the state with railroads.

It was while at Buenopolis that I learned what the best of coffee tastes like when prepared by the coffee grower himself. In fact, in all Brazilian homes it is the custom to offer a cup of coffee to visitors, and the coffee is roasted and ground afresh each time it is served. It is not boiled as in this country, but is reduced to a fine powder and packed in a conical woolen bag; hot water is then poured through twice, and it is a percolation instead of a decoction that is served as a delicious cup of coffee. The Brazilian drinks a black cup (demitasse) of coffee about every hour during the day; in fact, it is brought to his room and his guest's at six o'clock in the morning. He claims that it is a beverage valuable for its stimulating influence upon the system, and produces a buoyancy of feeling with no unpleasant reaction; lessens the sense of fatigue and sustains the body under prolonged muscular strain, and that it does not disturb digestion, but refreshes and stimulates and retards tissue waste.

The difference in taste of coffee as found in our markets is principally due to two reasons: First, the roasting to either a reddish brown or a dark brown; secondly, coffee is picked when some berries are green, others red, and still others a dark purple, the latter being the ripe fruit. Thus we have three grades from each tree; add the difference in roasting, as mentioned, and you have six grades; then take the perfect berry, which is flattened on one side, and the spherical berry, the so-called Mocha, and that gives twelve grades of coffee. The berries are picked in the manner mentioned; should the planter wait until the unripe (green) berry becomes ripe (purple), the ripe berry would have fallen to the ground. Owing to the immense scale on which the coffee industry is carried on in Brazil, machinery must be used, whereas elsewhere the work is generally performed by hand; and the picking of the berries, ripe and unripe, at one time, which is not done so much elsewhere, as the berries on a small plantation are picked separately as they ripen, there comes into the market from Brazil this cheaper or poorer grade, and which has given Santos and Rio coffee such a poor name. But our best Java and Mocha is pretty certain to have grown in Brazil, from there shipped to Aden and reshipped here.

The Brazilian coffee is shipped via Sao Paulo as a rule to Santos, although much goes to Rio. I therefore retraced my steps to Sao Paulo, and from there traveled on the English line known as the Sao Paulo Railroad to Santos. This is the famous coffee railroad; it is some forty miles in length, and runs through an uninteresting expanse of country until it reaches the coast range of mountains, called the Serra do Mar, down which runs a cable road a distance of five miles in four inclined planes. A train coming up balances that on which you descend. The height of these

mountains is about two thousand five hundred feet; perhaps the steepest incline is ten per cent. This is the old line built some thirty-five years ago; its original cost was very great, running as it does upon the steep flanks of valleys, where much stonework was required. Owing to the peculiar topography of this section of country, enormous floods of rain fall during a single brief storm. In order to draw off these dangerous inundations, frequent sluices are built beneath the roadbed and massive conduits almost continuously follow its surface. Reaching the plain below, it is but a short run to Santos. In 1899 a second road running parallel with the one just mentioned had been completed at a greater cost even than the first one; this was done to accommodate the tremendous traffic in coffee.

Santos is the second seaport of Brazil in the value and importance of its exports. It is a hot, dirty, damp, unwholesome place. In the harbor steamers can come alongside the fine docks built of stone and the coffee cars are run onto the dock direct; then splendid hydraulic cranes are used to unload the cars directly onto the steamer—better facilities for such work than I have ever seen used elsewhere.

In Puerto Rico and Cuba, coffee is raised of good quality, but in such small quantities that it does not in the least affect Brazil's output to the world. In the Hawaiian Islands coffee of exceptionally good quality is produced, and more and more is being planted. Hawaiian coffee brings the highest price of any on the Pacific coast. In the Philippines the prospects are very bright. I have seen splendid orchards there, especially in the southern islands of the archipelago, known as the Sulu or Jolo group. On the Island of Jolo there are excellent trees, and they bear two years earlier after planting than in Brazil. While in the Philippines there are large tracts suitable for coffee growing, the conditions, especially as to labor, are not as favorable as in Brazil; then, too, the coffee-bearing area of Brazil is much greater than that of any other coffee-producing country.

While we may draw a very considerable amount of coffee from our own possessions in the future it does not seem probable that we can ever produce enough for our own consumption. Nevertheless, the coffee produced in the Hawaiian and Philippine Islands is of good quality and ranks among the best in the world. It would therefore be profitable to invest American capital in our possessions in the Pacific, as well as in Puerto Rico and in the Republic of Cuba.

## ANTARCTIC EXPLORATION.

By EDWIN SWIFT BALCH.

WITHIN the past year three expeditions have started and now another expedition and also a relief ship are about to start for the Antarctic. It is evident, therefore, that there is a good deal of desire to learn new facts about the south polar regions, and some results may be looked for in the next few years. While looking to the future, however, the past should not be forgotten, and it is imperative that some American geographers should look backward, review the results already accomplished and insist that the great work done by Americans in the Antarctic receive due recognition.

To anyone who begins to investigate the Antarctic, the first question which naturally suggests itself is "What is the Antarctic?" and the inquirer will soon find that this is not an easy question to answer accurately. The Antarctic perhaps is all the space between 60 deg. south latitude and the South Pole, for the reason that Antarctic lands extend nearly to that degree of latitude, lands with the same characteristics of fauna, flora, climate, etc. Whether an irregular line would be more descriptive of the region is not yet agreed on, but there are several islands north of 60 deg. south latitude, Kerguelen and Bouvet Islands and South Georgia, which might be considered as belonging to the Antarctic. Probably it would be sufficiently accurate to consider these islands as belonging to a semi-Antarctic region.

Beyond 60 deg. south latitude two great masses of land are known, the one south of South America, the other south of Australia. The first has been traced, speaking in general terms, to 70 deg. south latitude, the second to 78 deg. south latitude. Various signs point strongly to the fact that these two masses of land are really one and that they extend clear across the South Pole, forming a continent. The existence of this continent was first recognized by Lieut. Charles Wilkes, of the United States navy, in the year 1840, and his discovery places him among the foremost explorers of all ages. He called the lands he discovered and along which he coasted for over 1500 miles, "The Antarctic Continent," but the general good sense of geographers has justly changed the name for the portion he explored into "Wilkes Land."

The term "The Antarctic Continent" would undoubtedly apply to the entire mass of land near the South Pole, just as one could say "the American Continent" or "the Eurasian Continent." But, probably on account of the length of this term, there is a move toward calling the south polar continent "Antarctica." It is a natural evolution and it may, I think, be looked on already as an accepted fact. Who first used the term as a proper name is probably at present uncertain, but one of the little tracts giving an account of the voyages of Amerigo Vespucci and published at Strasburg in 1505, was called *De Ora Antarctica*, so that the term has the sanction of age.

A difficulty now arises. The center of this probable continent is not known, but the two ends are, if somewhat vaguely. How is one to distinguish which end one is speaking about? A German writer not long since evidently found himself confronted by this difficulty, for he published a paper in 1888: "The Development of Our Knowledge of the Lands in the South of South America." And anyone to-day who wanted to speak of the lands south of South America or of the lands south of Australia, would find the same difficulty, for all the names in use are to a certain extent local names. For instance, south of South America one finds the South Shetlands, the Powell Islands, Palmer Archipelago, Louis Phillippe Land, Danco Land, Foy Land, Graham Land, Alexander Land, etc. Some

geographers have tried to call this land complex Gertrist Land, but it turns out that Gertrist did not go to the Antarctic at all. English geographers, under the impression apparently that Graham Land was discovered by Biscoe in 1832, mark Graham Land in big letters on their charts, although there is no apparent record of anyone of the name of Graham among Antarctic explorers. But a neglected paper "Executive Document No. 105," of the twenty-third Congress of the United States, dated 1828, tells how Benjamin Pendleton, of Stonington, had been on a coast and explored a great bay or strait in the very spot which Biscoe reached in 1832.

A continued study of Antarctic explorations soon forces to one's notice the absolute need of special names to distinguish the two great known masses of land in the Antarctic, and it seems as if evolution solves the problem there as well as everywhere else. The whole mass is becoming known as "Antarctica;" one end is in longitude west, the other in longitude east of Greenwich, and the names "West Antarctica" and "East Antarctica" suggest themselves at once as accurate, concise and descriptive. Whether geographers will see fit to adopt these terms remains to be seen, but I would like to suggest these names as, in my opinion, answering perfectly to the necessities of the case.

The entirely unknown portion of this probable "Antarctica" is pretty big. Dr. Supan estimates it at twice the size of Europe. Antarctica probably, judging from fossil remains, was bigger in former eons, and was at various times connected with Australia, South America and Africa. Of the partially explored portions, less is known of that than of any other part of the world's surface, perhaps partly because of its distance from the centers of thought and partly because of its dreary, inhospitable, barren nature. Animal life is almost wanting in Antarctica and human life is entirely so, and not the least interesting fact connected with its history is that there seems to be no record of any woman having crossed the 60th parallel of southern latitude.

The Antarctic fauna is decidedly odd. In the main it consists of whales, seals and penguins. The habits of the seal and penguins are strikingly analogous. The seals live in the water and come onto the ice to sun themselves, while the penguins live on the ice and spend a large part of the time in the water catching shrimps. Except for the trifling difference that one is a bird without wings and the other a mammal with neither arms nor legs, there is surprisingly little dissimilarity between the two. There are no land animals in Antarctica, and this will be one of the greatest hindrances in exploring it, as the penguin appears to be almost unfit for food. Dr. Cook describes the flesh as appearing to be made up of an equal quantity of mammal, fish and fowl, and as tasting like a piece of beef, an odoriferous codfish and a canvasback duck, roasted in a pot, with blood and cod liver oil for sauce. A few insects, a few fishes and a little reindeer moss complete the list as now known of life in Antarctica.

There have been three distinct periods in the ideas of geographers about the Antarctic; the first, when it was believed that there was land at the South Pole; the second, when it was believed there was ocean; and the third or present period, when there is a growing tendency to return to the original belief.

The first period certainly goes back to some time before the Christian era. A number of writers among the ancients mention vaguely that there must be lands in the south. A Chaldean, Seleukos, who lived on the Tigris between about B. C. 175 to B. C. 125, is perhaps the earliest savant known to have held such a belief. Aristotle, Hipparchus, Marinus of Tyre, Krates, Eratosthenes, Aratus, Strabo, Geminus, Pomponius Mela, Macrobios and Manilius also guessed at southern lands. The idea comes down through the Middle Ages with Baeda Venerabilis, Rhabanus Maurus, Guillaume de Conches, Albertus Magnus, Roger Bacon and one or two Arab geographers. Several old maps show some of their ideas, one of which was that Africa, south of Zanzibar, extended eastward to beyond the Malay peninsula, where it rejoined the Asiatic coast, forming a closed-in Indian Ocean. All these early ideas, however, are mere guesses.

In the year 1502 comes what must be looked on, probably, as the first discovery of a semi-Antarctic land. On his third voyage, Amerigo Vespucci sailed southeast from the South American coast, and reached a land in 52 deg. south latitude. The probability seems to be that this was South Georgia, but it must be said that Humboldt thought it was the coast of Patagonia. During the sixteenth, and also the seventeenth century, on many old maps a great "Terra Australis Incognita" is represented as stretching completely across the South Pole. On some maps, however, the region is represented as an ocean. Sometimes Tierra del Fuego is represented as a part of the Terra Australis and sometimes it is not. The great Terra Australis on many of these maps extends north almost to Java even before 1550, and it is impossible not to have the conviction forced upon one that Australia must have been sighted before that date, although there do not appear to be any records of the discovery. It may be incidentally remarked that on some of these maps before the year 1600, Alaska is marked quite accurately in shape and position, as is also Bering Strait, although Bering did not come round there till another century had slipped by. The whole "Terra Australis," however, was at best a very vague idea.

A. de Herrera's book about the West Indies was published in 1601 and it was republished in three languages in 1622. In this later edition a passage was added, saying that in the year 1599 a Dutchman, Dirk Gerrist, had discovered land south of Cape Horn in 64 deg. south latitude. This has been accepted as correct until about four or five years ago, when two documents were discovered in the Dutch archives, one of which says that Gerrist went only to 56 deg. south latitude, and the other that one of his men, Laurens Claes, of Antwerp, went to 64 deg. in 1603 with a Don Gabriel de Castiglio, only Claes does not say anything of land. The matter is not yet cleared up, but the fact remains that West Antarctica does lie south of Cape Horn, that it extends across 64 deg. and

that this fact was published in 1622. It seems as if somebody must have seen land, although at present it does not seem possible to say who.

Through the next century the great "Terra Australis" kept bobbing about on various maps, some minor discoveries were made, and several captains crossed the 60th parallel. LaRoche, Sharp, Cowley, Davis, Rogers, La Barbinais, Shelvoke, Roggeveen, may be mentioned among them.

In 1738-39 comes the first genuine attempt at Antarctic exploration, the honor of which belongs to France. Des Lozières Bouvet, a French naval officer, sailed south of the Cape of Good Hope for a long distance along the edge of the Antarctic ice, and while so doing he discovered Bouvet Island, which is in 54 deg. 26 min. south. His discovery was doubted, of course, and some people said he had only seen clouds. After him came Ducluz Guyot, Marion du Fresne and then Kerguelen, who discovered in 1772 Kerguelen Island. He also was violently abused, and some people said he also had seen only clouds. In 1772-75 Captain James Cook made the first circumnavigation of the Antarctic. He went repeatedly beyond 60 deg., several times beyond the Antarctic Circle, and on one occasion reached 71 deg. 10 min. south. He did not sight any portion of the southern continent, and his trip did away completely with the belief that land extended anywhere north of 60 deg. He closes the first period of Antarctic discovery, the belief now becoming general that the Antarctic was ocean and not land.

The second period opens with the voyages of numerous sealers and closes with the voyage of Wilkes, which restored the idea of the existence of a southern continent. The early explorations were in West Antarctica, and they were pretty much all made in the way of business, that is, they were made by sealers engaged in what they called the "skinning business." In two or three cases, however, the travelers were officers of the English navy. Among these men may be mentioned Swain, Macy, Lindsay, Smith, Edmund Fanning, William A. Fanning, Sheffield, Bransfield, Palmer, Pendleton, Powell, Morrell, Johnson, Weddell, Foster, Biscoe, Rea, Binstead, Kemp, Smith was the first apparently to sight the South Shetlands in 1819. Edward Bransfield in 1820 probably made, on one of the Shetlands, the first landing in West Antarctica, at which time he made the first discovery of Antarctic vegetation. The most prominent of these men, however, was Nathaniel B. Palmer, of Stonington, Conn. As far as the records show, Palmer probably discovered and certainly first sailed along the northern coast of what present indications would point out as being the mainland of West Antarctica. His name was given to that land by a Russian explorer, Bellingshausen, who met Palmer at the South Shetlands in 1821, after Bellingshausen had just completed the second circumnavigation of the Antarctic, during which journey he discovered Alexander Land.

An English explorer, Biscoe, made the third circumnavigation of the Antarctic in 1831-32. He discovered Enderby Land in East Antarctica, and afterward reached the land in West Antarctica which, after that time, was called Graham Land, and which English geographers ever since have claimed as Biscoe's discovery. The executive document previously mentioned, however, which is dated 1828, is good proof that this land was reached several years before by Benjamin Pendleton, of Stonington.

In 1839 an English sealer, John Balleny, discovered the Balleny Islands, and also had a glimpse of the mainland of East Antarctica. All his journal says is: "Saw land to the southward," and "the ice was quite fast, with every appearance of land at the back of it." But he never suggested nor even suspected that he had seen anything but another island.

In the months of January and February, 1840, two expeditions reached the mainland of East Antarctica. One of these, the French expedition under Dumont d'Urville, sighted at one spot a great piece of land on January 19, which was called Adélie Land, and at another spot a row of ice cliffs, which was called Côte Clarke.

The other expedition was the United States Exploring Expedition under the command of Charles Wilkes. They saw an appearance of land on January 13, which was certainly the Balleny Islands, then on the 16th they sighted land more surely, "Ringgold Knoll," in 157 deg. 46 min. east longitude, and on the 19th they sighted quite positively Cape Hudson. Wilkes then followed the coast westward until the middle of February for over 60 deg. of longitude. His journey was accomplished in constant danger, amid fogs and storms and huge tabular icebergs, and it is one of the most brilliant exploits of the American navy. One of his ships was nearly crushed by bergs. His own ship, however, and that of Commander Ringgold, carried out their explorations and proved that there was a South Polar Continent.

On his return to Sydney, Lieut. Wilkes immediately announced the discovery of "the Antarctic Continent" to the Secretary of the Navy in the following letter, dated at Sydney, New South Wales, March 11, 1840:

"It affords me much gratification to report that we have discovered a large body of land within the Antarctic Circle, which I have named the Antarctic Continent, and refer you to the report of our cruise and accompanying charts, inclosed herewith, for full information relative thereto."

Two days later the first account of the discovery of a South Polar Continent ever printed was published in the Sydney Herald of March 13, 1840. This land is now called on most maps "Wilkes Land." It is scarcely probable that the charted outline of the coast of Wilkes Land is accurate, sketched in as it was during a single reconnaissance; but that there is the shore of a continent between about 154 deg. and 100 deg. east longitude, can scarcely be doubted by any one who reads Wilkes' "Narrative." The vast number of ice islands and tabular icebergs shows that there is some extensive nucleus which retains them in an uninterrupted line on nearly the same degree of latitude, and, moreover, these enormous bergs are not formed, according to most explorers, in the open sea. Along this extended coast neither any open strait nor any northerly currents were observed, and the absence of both are strong proof of a continental mass of land, rather than of an archipelago of islands.

It seems as if this discovery closed the second period of Antarctic discovery, which was the exact opposite of the first period in that the second period began with the belief in an Antarctic Ocean and terminated with the announcement of the existence of the new continent, Antarctica.

The third period extends from the year 1840 to the present day. All the discoveries made in this period tend more and more to show the existence of the continent of Antarctica. The names of the principal explorers of the third period are Ross, Crozier, Smiley, Moore, Heard, Dallmann, Nares, Larsen, Evansen, Kristensen, de Gerlache, Chun, Borchgrevink.

Two of these travelers are of special importance. The first is Ross, who, in the year 1841, discovered a coast, which he called Victoria Land, and which is evidently the continuation to the east and the south of the coast of Wilkes Land. He also followed a great ice barrier for over four hundred miles, reaching 78 deg. 4 min. south latitude. On his return north he passed four or five degrees east of Wilkes Land, which he never approached. Nevertheless, on the strength of the fact that Wilkes had sent Ross a chart before Ross started on which the Balleny Isles were marked, only some fifty miles too far to the north, and because Ross sailed over this spot, Ross did not put Wilkes Land on his map. To all the written statements of Wilkes about this in his various papers and to all the maps published by Wilkes, Ross paid no attention whatever, although Ross quotes from several of Wilkes' publications. I regret to say that some geographers still accept Ross' asseverations and omissions as accurate, and, apparently without any examination of the facts, leave Wilkes' discoveries off their charts. I want to protest against such methods in geography, and I hope some American and some continental geographers are going to take up this matter and compare the original documents, that is, the writings and the charts of Wilkes and Ross. The truth in science to-day is bound to be known.

The other expedition of the present period of especial importance is that of de Gerlache in the "Belgica," three years ago. The explorers first sailed through Gerlache Strait, then along the west coast of West Antarctica past Alexander Land; and then they wintered in the pack, drifting farther west, in about 70 deg. south latitude. The soundings made through the ice showed that they were over the shelf of a plateau, which rose toward the south, while toward the north it fell abruptly, going to show that they were on the edge of a continental plateau. Still more important were the meteorological observations. The mean temperature of the year was -9.6 deg. C., an extraordinarily low figure for that latitude. This low temperature can only be explained by the absence of land toward the north, and the presence of an Antarctic continent entirely covered with ice to the south. The hypothesis is based upon a fact which was observed by the expedition. Every time the wind blew from the north the temperature rose, even in mid-winter, to 0 deg. C., but did not ascend higher. As soon as the wind shifted and blew from the south, the thermometer descended abruptly, even in the middle of summer, to a low temperature.

In closing this brief account of Antarctic explorations, I wish to express the hope that some attention may now be given to the subject by American geographers, in order that men like Palmer and Pendleton may have justice done them, and especially to bring out the fact that the discovery of the continent of Antarctica is an American discovery, and a discovery which places Charles Wilkes at the head of American explorers.

#### WATER IN AUSTRALIA.

EVERYBODY knows that Australia is one of the greatest growers of domestic animals. At the beginning of 1900 there were 1,639,127 horses, 9,678,422 cattle and 72,624,735 sheep. A large number of these animals live in the semi-arid regions, where the water supplies are inadequate unless reinforced by artificial means. Both the government and private enterprise have for years been giving much attention to increasing the water supply, with the result that they have augmented the ability of Australia to raise live stock so far that millions of animals are now growing where grazing was formerly impossible.

According to the New York Sun, at the end of 1900 the government of New South Wales had completed the sinking of eighty-two wells, fifty-six of which brought water to the surface, while it was necessary to use pumps in eighteen and the remaining wells proved failures. The daily water supply provided by these wells is 32,700,000 gallons. The deepest well is the Dolgelly, on the nearly rainless grazing lands in the northern part of the State, west of the mountains. This well is 4467 feet deep and supplies 745,000 gallons of water daily.

The Kenmare bore, several hundred miles further out on the plains, is not nearly so deep, for it is only 1682 feet in depth, but it provides a far greater quantity of water, the daily supply being 2,050,000 gallons. Another noteworthy well on the northern plains of New South Wales is that at Para, which is 1262 feet deep and supplies 300,000 gallons a day. The experiment has been made here of raising crops by irrigation on the grass lands. About fifty-six acres are under plow and irrigation and fruits and vegetables are being raised with great success. Similar experiments have been made near the artesian wells at Native Dog, Barrington, Cungonia, where lucerne, maize, tobacco, wheat, sugar cane, pineapples, dates and other fruits are grown in great quantity and of excellent quality. This proves that the vast plains of Australia, now devoted almost wholly to stock raising, have every requisite for successful farming except adequate supplies of water.

Seven artesian wells have been dug on the formerly waterless route from Wanaaring to Milparinka. They supply 2,300,000 gallons daily. Other borings further north also give good results.

Besides these government borings many private individuals have dug wells in New South Wales which give a daily supply of 45,000,000 gallons.

The statistics of Queensland up to July, 1899, show

a similar proportion of successful government borings. Of forty-one attempts to reach water, sixteen were successful. The railroad companies have also added a considerable number of artesian wells, but private activity has contributed by far the largest amount of water to the pastures. Of 582 private borings, 356 were successful. The daily supply of water from the government wells is 8,400,000 gallons, the total supply from all the wells in the State being 213,853,000 gallons a day. The deepest government well is at Winton, far out on the plains, 430 miles from the east coast; but the greatest quantity of water is supplied by the Charleville well, 420 miles west of Brisbane, which yields 3,000,000 gallons a day.

The waterless stretches of plain in South Australia have been the scene of many borings under the auspices of the Water Conservation Department. The best apparatus for sinking artesian wells was secured for this work from California. Only thirty-three of these attempts, however, have proved successful. The wells are strewn along the southern part of the colony where the desert approaches the sea. On the western frontier also a fine artesian well has been opened on the Nullarbor Plains. In the far north a well at Koppernannen on the east shore of Cyre Lake is 3230 feet deep and the best in the colony. It supplies 800,000 gallons daily. The total supply of artesian water in South Australia is 1,449,000 gallons a day. It is thus seen that the artificial water resources of South Australia are far inferior to those of New South Wales and Queensland. The well-watered lands are devoted mainly to wheat, and while South Australia is very important in grain raising it is inferior in live stock.

The government of Western Australia has bored a series of artesian wells in the direction of the gold mines of Coolgardie and toward the frontier of South Australia. It has contracted for many more wells and intends to do everything it can to increase the artificial water supply. It now has sixteen wells, yielding 4,806,500 gallons daily. The deepest well, sunk about 2000 feet, is at South Perth and yields a daily supply of 1,120,000 gallons.

Victoria has not been very successful in its efforts to secure artesian supplies. In many of the borings water was reached, but was so salt that it was worthless. Enough good wells have been developed, however, to pay for the efforts made.

#### A NEW CENSUS MACHINE.

M. MARCH, chief of the Bureau of Statistics, who had charge of the operations connected with the taking of the last census in France, has devised an apparatus that permits of registering in their entire extent the manifold answers figuring on the census cards to be abstracted. This machine, which is called a "classi-compteur-imprimeur" (printing classification counter) comprises simple mechanical combinations only. It occupies scarcely double the space of an ordinary typewriting machine and lends itself with remarkable ease to the inscription of all the indications noted upon the individual bulletins without omitting any of them, and totalizes them in measure as they are registered.

The apparatus comprises two essential parts—a horizontal table carrying six counters or registering devices, *CC*, arranged in six rows of ten each, and a keyboard analogous to those of typewriting machines and comprising sixty keys, *TT*, corresponding respectively to the sixty counters. When a key is depressed it bears against a lever which, through the intermediate of a rod, causes the counter with which it is connected to advance by one division. Under such circumstances it will at once be seen how the abstracting of any card is effected. In measure as the operator takes his data from such card, he depresses the key

the order number of the card abstracted, each of the indications taken from such card having, by super-addition, been noted upon the same band by a perforation made by needles corresponding to the various counters; so that the position of the holes upon the sheet repeats the indications registered by the counters. The apparatus, as may be seen, verifies itself.

The counters, comprising each of the four figures, are capable of registering as many as ten thousand operations without its being necessary to proceed to any notation thereof. After a series of ten thousand cards, for example, has been abstracted, it becomes

the keyboard, it was of importance to give him a means of correcting such error before the inscription thereof by the counters. To this effect, M. March has arranged upon the side of his apparatus opposite that on which is placed the handle, *M*, another handle, *N*, the object of which is to raise the depressed keys before they have acted upon the controlling rods of the counters.

M. March's apparatus possesses manifold advantages over all similar ones invented up to the present time, in that (1) it permits of the direct abstracting or epitomizing of the census cards without a preliminary

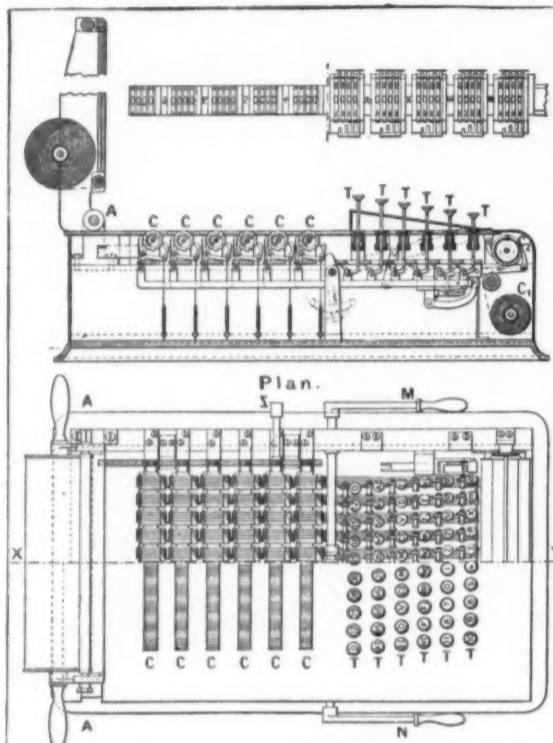


FIG. 2.—SECTION AND PLAN OF THE MACHINE.

necessary to inscribe the result. In order to prevent possible errors of transcription, and, at the same time, to assure rapidity of registering, M. March has made it possible for his machine to effect the indispensable notation. Such notation, moreover, is done in the simplest manner possible. A frame movable around an axis, *AA*, supports a sheet of paper actuated by special rollers corresponding to the various rows of counters, above which is arranged a ribbon charged with a fatty ink (Fig. 1).

Upon lowering the frame the rollers bear against the sheet of paper and in this way print the dates that they have totalized.

As may be seen, it suffices, then, to repeat this maneuver after each ten thousand operations in order to have inscribed upon the same sheet (owing to the fact that the latter displaces itself a little every time through a slight rotation of the cylinders) the various

transcription upon special cards, as is necessary with the Hollerith machine; (2) it gives definite results with the first manipulation of the cards; (3) since the control of the registering apparatus is mechanical, there is no fear of errors in reading or transcription; (4) after the abstracting of each series of cards, all the counters having been brought to zero, the operations are greatly simplified, since differences never have to be established between the consecutive numbers registered; (5) it is easily manipulated, its operation is correct and it requires but slight attention from the person whose business it is to maneuver it; (6) it permits of rectifying, before final registering, the errors made at the moment of depressing the keys, and gives a constant control of all the operations performed, as well as the continuous totalization of the number of cards abstracted.—For the above particulars and the engravings, we are indebted to *La Nature*.

#### ELECTROLYTIC REDUCTION OF LEAD.

On the subject of the electrolytic reduction of lead, Pedro G. Salom read a very interesting paper at the recent Philadelphia meeting of the American Electrochemical Society. He described the process invented by him and in use by the Electrical Lead Reduction Company at Niagara Falls. The ores that are reduced are sulphides of lead. They are used as cathodes in an acid electrolyte. The hydrogen ions combine with the sulphur of the ore and form hydrogen sulphide, which escapes as gas, while the lead sulphide is reduced to lead. This is the principle of the process. The apparatus used resembles in a general way a pile of dinner dishes of lead, piled one above the other. Each of these dishes represents a cell, the under side of a "dish" being the anode of the lower cell, the upper side the cathode of the upper cell. With 48 cells in series they use 130 volts and get two pounds of lead per horse-power hour.

The lead obtained in this process is in spongy form, and is then used for making other materials, like litharge. Owing to its spongy form, the lead is very readily transformed into litharge. Samples of spongy lead, compressed lead, litharge and other materials were shown. In future it is also intended to make accumulator plates.

The principal difficulty in the practical operation of the process was that the reduction was not complete, and that under apparently identical conditions the degree of reduction was not the same, especially as lumps of ore in the immediate neighborhood of the cathode plates were not reduced.

In the discussion which followed the following explanation of this fact was offered: When the electrolysis begins the parts of the ore near the electrolyte are reduced; when the electrolysis progresses the current may prefer to pass through the reduced lead to the cathode, hydrogen being developed and no lead sulphide being reduced. According to this view, the efficiency of the reduction would gradually diminish with progressing electrolysis. This would explain the fact that especially lumps of ore remote from the electrolyte are not reduced.

At present they have succeeded in improving the reduction so that about 92 to 95 per cent of the lead sulphide is reduced to lead. Another difficulty experienced was that the workmen's eyes were affected

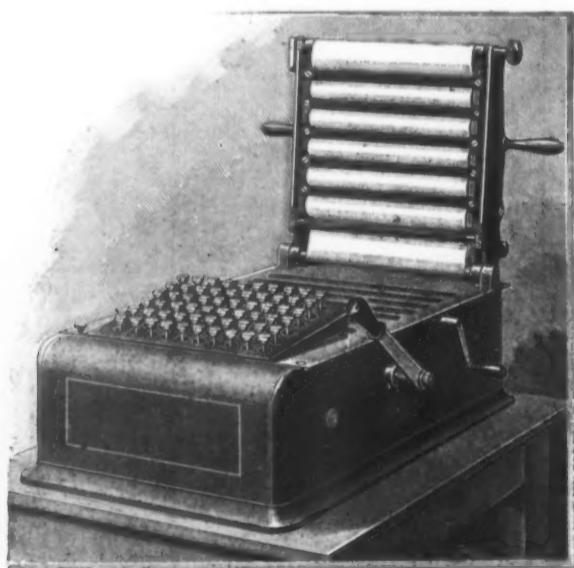


FIG. 1.—THE MARCH CENSUS MACHINE.

reserved for the notation thereof. After all the indications of an individual card have been registered thus by the keyboard it remains to transfer them to the counters. This operation is performed in a single maneuver, simply by turning down the handle, *M*. Consequently, all the controlling rods are actuated simultaneously and each of the counters involved advances by one division. At the same time, a special counter, set in operation by the handle, *M*, prints upon a band of paper unwinding automatically from cylinders, *C*, *C*<sub>1</sub>, inclosed in the base of the apparatus, the number of the operation registered; that is to say,

numbers representing, for each sort of information, the series epitomized from every ten thousand bulletins.

Naturally, after each of these registrations upon the totalizing sheet, the sixty counters are brought back to zero. This latter operation, moreover, is performed in an instant by revolving the winch, *Z*, fixed to the side of the apparatus.

Finally, to complete his remarkable invention, M. March has added to it another member.

Since, in the course of such a series of operations, it is inevitable that there shall occur an error due to the fact that the operator has pushed the wrong button of

during the operation by the escaping gases; but this difficulty appears to have been overcome.

As the developed gases are hydrogen sulphide and oxygen, in their combining proportions, it has been proposed to utilize them in gas engines, which then could develop more power than was used in the process. This apparent paradox was explained by Prof. J. W. Richards in the discussion.

The ores treated in the process contained no silver. No attempt is therefore made to refine the lead for producing silver.

#### VERTICAL DIRECT AND ALTERNATING GENERATORS.

By FRANK C. PERKINS.

SOME of the largest power plants installed abroad are operated from vertical turbines driving generators with rotating fields or armatures directly connected to vertical shafting of the waterwheels.

In this country as well, the Niagara plant illustrates the use of vertically-driven generators, which aggre-

#### ELECTRICITY IN ITS APPLICATION TO SUBMARINE MINES.\*

By CAPT. JOHN STEPHEN SEWELL, U.S.A.

A SYSTEM of submarine mines usually involves stationing torpedoes planted under water, anchors for holding them in position, cables for connecting them electrically with the shore, and operating apparatus in a sheltered position on shore. The torpedo itself is usually a metal case, containing a charge of suitable explosive, with necessary detonators, etc. It may, and in shallow water, usually does, rest on the bottom, the metal envelope being in this case sufficiently heavy to act as an anchor. In water more than thirty-five or forty feet deep the torpedo is usually buoyant, and is held in place by a separate anchor and mooring rope. Torpedoes may be purely mechanical in their action; in this case there are usually a number of movable pistons projecting through stuffing boxes at various points, and so arranged that if driven in by the impact of a vessel they will explode a detonator, which in turn will explode the torpedo. It will be readily granted that such torpedoes are dangerous to

and not weapons; their principal function is to prevent the enemy from running by the batteries, which experience has demonstrated that he can do if he has a clear channel. They must be located where, if he tries to remove them, he will be detained under the close fire of the shore guns; otherwise he would remove them and then run by. They must be sufficiently numerous to prevent his opening a channel through them by the sacrifice of any reasonable number of vessels sent in to receive an explosion and then turn to one side and sink out of the channel. They must be accurately located and planted in regular order, so that there will be no mistake about exploding the proper mine in judgment, firing, and that in case of automatic firing the exploded torpedo may be replaced with the least delay.

It is customary to plant mines in smaller and larger groups; usually more than one torpedo will be attached to a single cable core, and the various cores, as they approach the shore, will be gathered into a multiple cable of several cores. Thus, starting with a cable of ten cores, it should be laid by the most direct line from the operating casemate to a convenient point in the rear of the line of mines it is to serve; there, by means of a large junction box, it would be connected with ten single core cables, each leading to one of a line of smaller junction boxes; at the small junction boxes each single conductor branches into perhaps three other single conductor cables, each of the latter going to a torpedo. By this arrangement when firing is by judgment, which involves some uncertainty as to the actual distance of the hostile vessel from the mines, the defense explodes three charges at once, thus increasing the probability of an effective blow; if, on the other hand, the hostile vessel strikes a torpedo, only that one will explode, and being in contact with its target it ought to be sufficient.

Coming now to the electrical arrangements, if firing were by judgment alone, nothing would be needed but a circuit from the firing battery through the detonators in the torpedo to earth with a firing key in the casemate. Even very defective insulation would not interfere with the working of the system, if the firing battery is enduring and sufficiently powerful. It would interfere with the daily tests, however, because of the variations in resistance which would occur even if no leaks or other defects develop in the torpedo itself. If firing is by contact alone the necessary arrangements are a little more complex.

In order to admit of daily electrical tests—which must include the circuit through the detonators to be of any value—there must be a continuous circuit through the torpedo; it must be of high resistance, so that even if the firing battery is on it cannot fire the mine. There must be a circuit closer in series with the detonators and in parallel with the high resistance. When the mine is struck the circuit closer acts and opens up a circuit of low resistance through the detonators. It is assumed that the detonators are of the type having a continuous bridge of fine wire, surrounded by some fulminating substance, and that it is designed for a relatively large current under moderate emf. This is the most certain and reliable form and is always easy to obtain. If the firing battery is on, the torpedo should explode when the circuit closer acts.

It is desirable, however, to know whether a torpedo is struck, or whether its circuit closer acts from any other causes, even if the mine is not to be fired. Moreover, it is objectionable to keep the cables under such high voltage as is necessary in a firing battery. It therefore becomes desirable to have another battery of very constant emf. always on the circuit. Its emf. and all the resistances in circuit should be so proportioned that normally a tiny current is always flowing; but when a circuit closer acts this current should increase to such a point that it will drop a signal, showing to which triple group the torpedo belongs, and also close the circuit of the firing battery through the corresponding cable core. In case the torpedo is fired, the explosion may cause the circuit closers of neighboring mines to act and thus the whole system might go up, seriatim. To prevent this some device

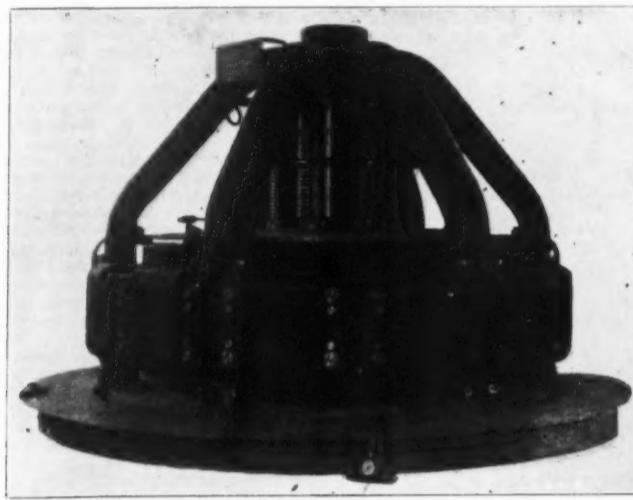


FIG. 1.—DIRECT-CURRENT DYNAMO FOR CITY OF GENEVA, CHEVRES STATION.

gate 100,000 horse power, in 5000 horse power units, now in operation or contracted for.

The machines installed abroad with vertical shafts represent both alternating and direct current types of machines, the latter being largely used for electrochemical purposes. Among the important alternating power plants using this type of machine are the central station at Chèvres near Geneva, shown in accompanying illustration; La Goule power plant; the Elektricitätswerk Olten-Aarburg; the Electric Supply Works at Rathausen, near Lucerne; as well as plants at Sihl and Aarau. The plant at Chèvres, near Geneva, Switzerland, is a two-phase alternating-current station operating at a potential of 5000 volts.

This plant was installed by the firm Brown, Boveri & Co., of Baden, Switzerland. Six two-phase vertical alternators were used, of the type shown in the illustration, Fig. 1, each having a capacity of 1200 horse power at 208 volts and 120 revolutions. The total output of the station was 7200 horse power, and one large switchboard was used, consisting of fifteen generator panels and a number of feeder panels.

The Olten-Aarburg plant has a total capacity of 3000 horse power, and also was equipped by the same firm with two-phase vertical generators unique in their way, as they are directly coupled to vertical shaft turbines running at the extremely low speed of 28 revolutions per minute.

The potential is 5500 volts, and two of the two-phase generators have each a capacity of 600 horse power; the remaining six have a capacity of 300 horse power each.

A much larger plant was installed for the Forces Motrices du Rhône in Lyons, having a capacity of 20,000 horse power. Sixteen vertical shaft generators were installed, each having a capacity of 1300 horse power and supplying a three-phase current of 3500 volts pressure.

La Goule Monophase power plant was installed by the Maschinenfabrik Oerlikon, of Oerlikon, near Zurich, Switzerland. This plant has a capacity of 2000 horse power, and the four vertical single-phase alternating-current machines supply a number of towns and villages in both France and Switzerland along the river Doubs, at distances up to 44 kilometers from the power house. The potential used is 5500 volts.

One of the largest direct-current plants using vertical generators supplying current for electrolytic or electro-metallurgical work is that of the Neuhauser Aluminium-Industrie Aktiengesellschaft in Rheinfelden. This plant was installed by the Maschinenfabrik Oerlikon for the reduction of aluminium from the ore in the electric furnace. These vertical direct-current machines weigh 100,000 kilogrammes and operate at the slow speed of 55 revolutions per minute. The output is 7500 amperes at a potential of 75 volts. The machines have an outside diameter of 6640 mm. and are of the 32-pole type, the armatures having a diameter of 4500 mm.

A direct-current vertical generator delivering 5000 amperes at 120 volts was recently installed in the works of the Kellner Partington Company, of Booregard, near Sarpeborg, Sweden. The field and armature may be seen in Fig. 2. This dynamo is a 600-kilowatt machine of the 16-pole type built by Brown, Boveri & Co., of Baden. It supplies a direct current of 120 volts when operated by the 890 horse power turbine at a speed of 180 revolutions per minute.

handle, and are not likely to remain long in an efficient condition in sea water. Again, in some rare instances, use may be made of what might be called self-acting electrical torpedoes, in which a battery and circuit closer, in series with an electrical detonator, are inclosed in the metal case along with the charge of explosive. The circuit closer is supposed to act under the impact of a vessel and the battery does the rest. Some form of dry cell is manifestly the only proper battery for such uses.

In planting self-acting mines it is necessary to have a safety device which will maintain an open circuit, in spite of the circuit closer, until the operations of handling and planting are completed and those engaged in the work have had time to put a safe distance between themselves and the mine. After this, such a torpedo is dangerous alike to friend and foe, and its removal is an exceedingly delicate operation. For this reason, and also because a thoroughly satisfactory safety device is very hard to find, self-acting mines have a very restricted sphere of usefulness.

By far the greater part of all submarine mines are electrically operated from the shore. This follows directly from a consideration of the conditions to be met in devising a system of mines. It is very desir-

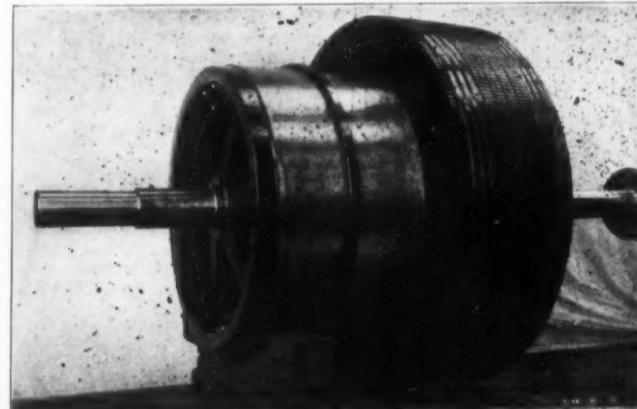


FIG. 2.—600-KILOWATT DIRECT-CURRENT ARMATURE FOR DIRECT CONNECTION WITH TURBINE.

able for a mine to explode automatically when struck by a hostile vessel, but it is equally desirable for it not to explode if it is struck by a friendly vessel; the defense should also be able to explode the mines at will from the shore, in case a hostile vessel comes near but seems likely to miss them. All these things are rendered possible by mines electrically operated from the shore.

It is necessary, of course, to proceed with accuracy and precision in order to attain successful results with such a system. Mines are, primarily, obstructions

is needed which will allow the firing current to flow long enough to explode certainly the mine that is struck, but which will break it immediately thereafter and keep it broken long enough for neighboring mines to right themselves. It should be remarked here that if ground mines are used for automatic firing the circuit closer must be carried in a buoy, similar in form to a buoyant torpedo anchored to the ground mine, and having an electrical connection with it; so that, with ground mines, the requirements are the same as with buoyant mines.

It will readily be seen that to accomplish all the above objects a more or less complicated set of apparatus is required. It is a good plan so to arrange the

\* Paper read at the annual meeting of the American Institute of Electrical Engineers, at New York, May 20, 1902.

signal drops that when they fall they will close a bell circuit, thus causing a bell to ring continuously until the signal is raised; it is also well for the device which cuts off the firing battery after an explosion to ring a bell as long as the firing circuit is open; this gives reasonable assurance that a mine has exploded, even if in the noise of battle the explosion itself is not heard; pilot lights would do as well as a bell. It is also well to have a very feeble battery for testing purposes only; thus it will already be seen that there may be as many as five separate circuits to provide for in the operating casemate. In addition there may be one more; if a torpedo is struck and fired the end of the cable leading to it will form an earth which, if cut out, might be sufficiently good to keep throwing the firing battery on; it would so alter the resistances as to interfere seriously with the proper working of the system at any rate. At the triple junction box a fuse could be inserted to carry the firing current, but susceptible of being blown by a more powerful one to be applied as soon as the other mines of the group have righted themselves. If now we assume that a small engine and dynamo are used, in connection with storage batteries, to supply current to various circuits, it will readily be seen that the switchboard problem in the casemate is not simple.

If, in addition to automatic firing, it is desired to use judgment firing, we must be able to switch out the high resistance in the mine, or else have this resistance in the form of the primary of an induction coil, with additional detonators in its secondary circuit; in this case an intermittent or alternating current of high potential and small volume, flowing in the primary, would induce a firing current in the secondary. A whole triple group would then be fired, and the corresponding core of the multiple cable would be detached from the operating apparatus altogether, until such time as the mines could be replaced.

In purely automatic firing the high resistance might be omitted altogether, but then a break in the cable core would give the same indication as a mine in normal condition, and the torpedo itself might be filled with water and sunk to the bottom without the fact being discovered.

The daily tests consist in measuring the resistances of the various circuits and testing all movable parts in the operating casemate. Damage to the system always affects these tests and the expert electrician in charge must learn to infer, from his tests, what the probable nature of the damage is.

It will readily be seen that except for purely judgment firing the insulation resistance of cables and joints must be very high and must remain so. Details of apparatus actually in use have been omitted in this paper, because they are classed as confidential, but enough has been said to show to an electrical engineer that submarine mining presents some problems that demand serious attention. Not the least of these is the problem of junction boxes which will allow of rapid jointing work, of a quality sufficiently good to withstand submersion in sea water for months at a time. Another serious problem is the cable itself. It takes time to make it. If it is kept in store, either wet or dry, the insulation becomes brittle, and when the cable is unwound from the reels in laying the insulation cracks. Hitherto the cable used for this purpose has been insulated, taped and armored. While the work has been of a high grade, it seems to the writer that we will have to come to the use of cable having a lead covering outside or the insulation and steel wire armor outside of the lead. Then, as long as the lead is intact, cracks in the insulation will be of no consequence. But this form of cable will be heavier, harder to handle, more difficult to splice, and considerably more expensive than the armored cables without the lead.

Even after the details of a system of mines are satisfactorily worked out, the planting is a very serious matter, and always will be, unless we discover some way of controlling and firing the mines by induction, without electrical connections from the shore, thus eliminating the cable. Possibly the development of wireless telegraphy may ultimately make this possible, but it is not yet in sight.

#### BLUE-PRINT AND BLACK-PRINT PHOTOGRAPHIC PAPERS, AND THEIR PREPARATION.\*

By ALFRED I. COHN.

THE introduction of blue-print paper as an article of trade is due to the observation made by Sir John Herschel, in 1840, that ferric ammonium citrate (and, in fact, many other ferric salts) is reducible to a ferrous salt by the action of sunlight. This observation led him to utilize the various color reactions given by the iron salts, and to apply them practically in the reproduction of plans, designs, etc. Thus he was the first to sensitize paper with a solution of ferric ammonium citrate, and develop it with potassium ferricyanide (the ordinary blue-print paper), or with gold chloride (the chrysotyph process, yielding white lines on a purple ground). He was also the first to make positive blue prints, by developing the paper sensitized as above, with a solution of potassium ferricyanide and gum acacia; by exposing paper sensitized with a solution of potassium ferricyanide; and by developing ferric-chloride paper with calcium-iodide and starch solution, whereby the iodine is liberated, and reacts with the starch.

The methods employed by Herschel were not, however commercially utilizable, because the prints obtained were not uniformly good, while the process was too inconvenient and not sufficiently rapid. Another serious defect was the instability of the prepared paper. The paper, when just made, gave good results, but on keeping a few days, sometimes even a few hours, the whites of the prints were no longer white, but varying shades of greenish-blue. It soon became necessary to have greater certainty and simplicity, and a number of experimenters attacked the problem, with varying success.

Almost every ferric salt was tried in the endeavor to make a more stable paper. Among the salts tested were ferric chloride, usually in conjunction with oxalic,

tartaric, citric, lactic, or other organic acid, ferric ammonium citrate, tartrate and oxalate, and ferri-sodium oxalate. Ferric chloride, together with oxalic acid, is by far the most rapidly affected by light, but the paper prepared with the mixture deteriorates very rapidly, even in the dark. The one found most suitable was the ordinary ferric ammonium citrate, occurring in the well-known form of brown scales. This salt was the one chiefly used for many years, and until a modification of the salt in the form of handsome green scales was prepared. This form was found to be not only far more sensitive to light, but to be more stable as well, and hence it is the one most largely in use to-day in the manufacture of blue prints. This green salt differs from that occurring in the form of brown scales in having a smaller iron content. It is made by a modification of the method used in manufacturing the ordinary salt.

In the manufacture of blue-print paper a number of precautions must be observed. The mechanical difficulties will be treated of when discussing the machinery employed in sensitizing the paper. In preparing the solution, the potassium ferricyanide should first be washed, that is, it should be shaken with a little cold water to dissolve the exterior coating of the salt, because, as Herschel has shown, the salt is reducible by light, and if it has been kept for a while and particularly exposed to strong light, the surface of the crystals will have undergone a slight decomposition, and hence, when making the prints, perfectly white lines will not be obtained. It is well not to keep the solution of ferric ammonium citrate on hand long, as it soon becomes moldy and spoils; it is, therefore, better to prepare blue-print solution just before using. Solutions for sensitizing have been made of varying strengths by different experimenters, the proportions varying between 8 to 12½ per cent for the ferric ammonium citrate and 4½ to 8 per cent for the potassium ferricyanide. An excellent solution may be made from 12.5 grammes of the green ferric ammonium citrate, 4.5 grammes of potassium ferricyanide, and 100 c.c. of water. The solution should be filtered, and the application to the paper made by gaslight—never by daylight.

Due regard must be had to the quality of the paper itself also. A good quality of well-sized paper gives the best results. If the paper is unsized, or not sufficiently sized, the solution soaks in too far, sometimes, almost to the back of the paper, and it is then difficult, if not impossible, to get pure whites; furthermore, the prints assume a dull color.

Ordinarily, care should be taken to work with a neutral solution, for if a few drops of ammonia or other alkali be added to the solution, the finished print, while it will have a remarkably handsome dark-blue color with a coppery luster, will fade on exposure for some time to light; while, if the solution be acid, the keeping qualities of the prepared paper are impaired.

Blue prints may also be toned or changed in color by various substances; for instance, on immersing the finished print in a very weak solution of ammonia the blue of the print is decomposed, and in its place appears the reddish-brown of ferric oxide. On now immersing the print in a solution of tannic or gallic acid, a black color is developed in place of the original blue. Potassium sulphocyanate would give a red. Of course, it is understood that, under a positive drawing or design, a negative print, i. e., a print showing the design in white lines on a blue ground, results; naturally, when toning blue prints, the corresponding prints are also negatives.

Mention has already been made of the positive blue prints obtained by Herschel. These, as made by the latter, were poor in color, nor could the paper be made to yield prints of uniform appearance, because of the sinking in of the solution too deeply into the paper. The beauty exhibited by well-finished prints, however, led a number of investigators to experiment with this process with a view to its improvement.

The first notable improvements were made by Henri Pellet, in 1881. This experimenter used a mixture of ferric chloride with either oxalic acid, sodium citrate, tartaric acid, or citric acid; or a mixture of ferric chloride with ferric ammonium citrate, and developed the prints with potassium ferricyanide. In this process, too, good results could not be obtained, chiefly because of the fact that the acid used rendered the ferric chloride too readily prone to change. It remained for Messrs. Pizzighelli and V. Itterheim to modify Herschel's process, and devise a method that would give uniformly good prints. The mixture they proposed is as follows: (1) Gum acacia, 20; water, 100. (2) Ferric ammonium citrate, 50; water, 100. (3) Solution of ferric chloride, 50; water, 100. Of these solutions, first mix 20 vols. of No. 1 with 8 vols. of No. 2, and then add 5 vols. of No. 3. This order of mixing must not be departed from, otherwise the mixture will be useless. The mixture when made thickens in a few minutes to the consistency of soft butter. It is set aside over night to "ripen," and used the next day.

In this process, it is absolutely essential to use a well-sized paper, otherwise a clear print cannot be obtained. The proportions of the two iron salts may be varied somewhat without danger, but that of the gum should be as stated, for if more be used, the solution cannot be applied uniformly to the paper, and the finished prints will hence show blue spots which are sometimes very troublesome to remove. On the other hand, if less gum be used, the solution will sink too far into the paper, and the finished prints will be either bluish throughout or will be very dull and "flat."

The development is effected by applying a 20 per cent solution of potassium ferricyanide with a brush, passed over the print in parallel strokes. The image starts out in pale-blue lines on a greenish-blue ground. The print is then immersed in very dilute sulphuric or hydrochloric acid, in which the image becomes at once deep blue, while the greenish-blue ground disappears and gives place to a pure white. The print is then finished by washing thoroughly with clean water, to remove the acid, which, if left in the paper, would soon render it brittle. Any spots on the print, should such occur, may be removed by the cautious application of a caustic soda or potash solution, followed

immediately by a liberal supply of clean water. The finished prints are very handsome in appearance. One experimenter, Dr. Zoelner, in 1863, devised a method whereby paper sensitized with a solution of ferric chloride and ferric oxalate was developed with a solution of potassium iodide in albumen—in fact a variation of Herschel's process.

While these negative and positive blue prints are very handsome and serviceable, the ideal print was nevertheless considered to be one that would present a facsimile of the tracing or design in black characters upon a white ground. This result was first accomplished by Poitevin, in 1860, who sensitized paper with a mixture of ferric chloride, tartaric acid, and water. A paper so sensitized presents a yellow appearance, but on exposure to light, it becomes colorless, because the green ferric chloride, to which the ferric is reduced by light, is colorless in very thin layers. The paper prepared by Poitevin gave prints, but bad ones, because the solution invariably sank deeply into the paper, sometimes to the very back, with the result that the developed image frequently appeared stronger from the back than from the face of the print. The development was effected by plunging the print into solutions of gallic or tannic acid, hence the iron deep in the paper, not being completely washed out, invariably imparted a decidedly purple color to the background.

Later experimenters modified Poitevin's process with a view to prevent the deep penetration of the sensitizing solution into the paper. These modifications consisted in adding gum acacia, starch, gelatin, arrowroot or other similar substances to the solution, thus keeping it more on the surface of the paper; or, the paper itself was first sized with these gummy substances before the solution was applied; in some cases both methods were combined. The general composition of the solution was retained, however, with but slight modifications. For instance, some experimenters added a little ferric sulphate and sodium chloride, some replaced the tartaric acid by oxalic acid, some added a little ferric sulphate solution; others added some ferric sulphate, etc. It remains to be said, however, that all of these processes required the development, after exposure of the paper in a solution of gallic or tannic acid. Nor could any of the papers be made to remain in a serviceable condition for a sufficient length of time to make them commercially practical.

The necessity of developing by using a solution of gallic or tannic acid was also an inconvenience, and a demand arose for a paper that would afford black lines on white ground, but which would require no other treatment for developing it than simple immersion in water. The problem here presented was a very neat one. Practically it was thus: Prepare an aqueous solution which, when applied to paper, would be sensitive to light; the parts of the paper untouched by light should, however, be blackened on contact with water, while the light-affected parts should not.

Some ten years ago the author undertook to study this problem, and succeeded to a certain extent in solving it. The well-known fact that ferric chloride gave no reaction with tannic or gallic acid in the presence of strong mineral acids was used as the starting point in the investigations. All the inorganic acids, as well as all the organic ones that could be considered as eligible from a commercial view, were tried. It was soon found that the inorganic acids could not be used, as either the paper did not print at all or did so too slowly.

Oxalic acid was found to be the best, so far as rapidity of printing was concerned, provided the paper could be used at once. Other organic acids, such as tartaric, lactic, etc., were also useful, but larger quantities were required. The proportion of acid to the ferric chloride and tannic or gallic acid could not be fixed to a constant, as various papers required varying quantities of acids.

Of all the papers tried, only one has been found that could in any way be relied upon, and this is the Steinbach paper, made especially for the black-print process; but even with this sensitized paper is with difficulty made to keep sufficiently long for commercial purposes.

After a long series of experiments it was finally found that a mixture of oxalic and tartaric acids gave the best results, using, however, a mixture of tannic and gallic acids also.

Some of the difficulties encountered are as follows: When too much acid is used, the print washes entirely (or nearly so) off in the development; further, the paper in a short time becomes so brittle that it may be readily and easily crumpled almost to dust in the hand. (The author has observed this phenomenon also on keeping some tartaric acid in paper for a while, the paper becoming very brittle, and crumpling on the slightest touch.) This is most likely due to the formation of hydrocellulose from the action of the acid on the paper. Again, if too little acid be used in the solution, the sensitized paper rapidly becomes darker and darker and finally almost black, and either does not print at all, or requires so long a time as to make the paper useless commercially. Paper sensitized with solutions containing ferric chloride and some organic acid print more quickly than when other ferric salts are used, but such papers are far more unstable than the others, due to the fact that the organic acids themselves act as reducers of the ferric salt, even in the dark, and the ferric salt so formed promptly proceeds to become oxidized, not to a ferric state, but to an oxy salt, which affords the reactions given by ferric salts, yet is insensitive to light, even in the presence of organic acids, etc.

So far as the author is aware, no positive method has as yet been found to prevent this change from occurring, nor from the nature of the chemical, and the conditions under which it is here used, are any likely to be found.

Besides the processes in which iron salts are used for preparing sensitized papers yielding positives (from positives), there are also others, based on the employment of salts of chromium, manganese, cobalt, and cerium, and also of certain diazo compounds.

When a bichromate is exposed to the action of light in contact with organic matter, such as gum acacia, gelatin, glue, starch, etc., it undergoes reduction to

brown chromochromic oxide, while the gelatin, gum, etc., become "tanned." This action, whereby the gum, etc., is hardened, and rendered insoluble even in hot water, was discovered by Fox Talbot, in 1852, and on it are based a number of methods of reproducing designs which are of great commercial value.

It will, of course, be readily understood that, in using a paper sensitized with a mixture of gum, etc., and a bichromate, the development either of the light-affected parts, or of those covered by the lines of the drawing, etc., may be effected. In the former case the print is first well washed after exposure, in order to remove all the bichromate and gum not affected by the light, and which is still soluble in water. In the latter case the parts unacted upon by light are directly developed by various chemicals, e. g., with salts of lead (yellow), silver (red) and mercury (brown); by using a hot solution of logwood, a black print results.

It was further found that, if the sensitized paper, after exposure, were moistened, all the parts not affected by the light absorbed more or less moisture and swelled up, whereas all the light-affected parts remained perfectly dry and hard. A roller charged with ink could now be passed over the print, when the ink would adhere to all the dry parts of the print, while the moist parts would take up none at all. The print so made could now be either allowed to dry, or a copy of it could be made by simply pressing a clean sheet of paper over it. Of course the copy would be reversed in position, but if the original print be made in reverse a direct copy would result.

Another utilization of the hardening of the bichromate-gum (or gelatin) mixture consisted in adding carbon black (or even some colored pigment) to the sensitizing liquid before applying it to the paper; or, in sensitizing paper coated with carbon black (or some pigment) and gelatin, with a bichromate solution. In this case the prints are developed after exposure by washing in water, the parts not affected by light readily washing off, while the light-affected parts, having been rendered insoluble in water, remain.

While the theory of making these prints is correct, the actual realization of good prints is very difficult, because the pigment added prevents the light from striking through the film of sensitized substance to the paper. The consequence is that only the surface becomes insoluble, and when developing, the sensitive film washes free from the surface in spots, according to the intensity of the lights and shadows. To obviate this drawback the prints have been exposed with their backs to the sun and in contact with the face of the original. This method, too, is troublesome, as the appreciable thickness of the sensitized paper permits the light to be partially diffused under the lines to be copied, hence the lines on the print will not be so sharp or clean as they should be; furthermore, although the sensitive film is affected by the light next to the paper, the upper layer is not at all affected, hence it washes away during development, and the resulting print is apt to be weak in color.

In an attempt made to increase the sensitiveness of the film it was found that sodium bichromate was more sensitive than the potassium salt, while the ammonium salt was the most sensitive of the three. It was further found that the sensitiveness could be still further increased by neutralizing half the solution of the bichromate used with ammonia, and then adding this to the reversed half. By means of a solution so made fairly good results may be obtained. Of the three salts, however, the sodium salt is best adapted for the purpose; it is, moreover, much more freely soluble than the potassium salt.

The fact that bichromates are powerful oxidizers and are capable of affording light-resistant colors with aniline, was utilized by Willis in the process devised by him and known as the "aniline process."

In this process paper sensitized with potassium bichromate is, after exposure, subjected to the vapors of aniline, the result being that all the parts not affected by light are darkened in color on contact with the aniline vapors from the oxidizing action of the bichromate on the aniline, aniline black resulting. It was found, however, that the bichromate alone did not give good results, and that good prints could be obtained only when an acid was present. Further, the addition of an acid appeared to greatly increase the sensitiveness of the paper, but only up to a certain point, beyond which it again declined. The solution which was found to afford the best results was one containing 5 per cent of bichromate and 50 per cent of phosphoric acid.

Paper, sensitized with a solution so made, prints very rapidly, one-half to one minute in direct sunlight being sufficient under a good tracing. The prints are developed by suspending them from small wooden spring pinch-cocks in a vertical drawer or cabinet, below which is a box containing cotton waste or other suitable material, upon which is poured some raw aniline, and into which steam is conducted. The prints thus hang in an atmosphere highly charged with aniline and steam. After the development the prints are well washed with water.

The finished print, if properly made, is quite handsome and very permanent. In this process the exposure must be very accurately timed, and good judgment displayed in the development. An under-exposed print will acquire a dark greenish background which cannot be remedied in commercial practice; if over-exposed the lines of the print will be very weak or altogether absent. At times the lines of the print will have a greenish hue; when this occurs it may be remedied by immersing the print, after washing, in water to which a few drops of ammonia have been added. In this bath the lines acquire a bluish-black color. It is further essential, in this process, that crude aniline be used—the very refined or pure aniline either does not develop at all or does so very unsatisfactorily.

Some ten years ago Messrs. A. and L. Lumière carried out a series of investigations with a view to utilizing the salts of manganese, cerium and cobalt in photo-reproductive processes. The authors soon found that these salts were excellently adapted for the purpose. Of all the manganese salts manganese oxalate was found to be the most sensitive, but ineligible because of its instability. After experiments covering

all the organic acids, lactic acid was found to be the best for preparing a sensitive solution; and, further, the addition of some potassium formate considerably increased the sensitiveness of the solution so made, without impairing the keeping qualities of the prepared paper. The process followed by the authors for preparing the solution of manganese lactate was as follows: Potassium permanganate, 6 grms.; distilled water, 50 grms. Dissolve and add slowly under stirring, lactic acid (sp. gr. 1.225), 16 c.c.; after which, add potassium formate, 3 grms.

The solution is filtered and applied to paper previously coated with a thin layer of gelatin. The paper so sensitized is exposed under a positive, an exposure of a few minutes sufficing to completely reduce the manganese salt to a manganeseous. The parts unexposed to the light are then developed by various amines, phenols, etc.; different colors being obtained according to the developer used. For instance, aniline yields a green color; paratoluidine, a red; xylyl, a yellowish brown; benzidine hydrochloride, a deep blue; guaiacol, orange; resorcin, pale yellow; paramidophenol hydrochloride or sulphate, brown; and pyrogallol, violet-black.

Positive prints may also be obtained from positives by using salts of cerium. Among these, ceric sulphate and ceric nitrate are best adapted for use. Paper is sensitized with a solution of one of these salts just as is done with the manganese lactate solution, and is exposed under a positive. When all the parts exposed to the light have become colorless the print is developed and fixed by simply treating with a solution of an amine, phenol, etc., just as is done with manganese prints. For instance, aniline and its salts give green prints; alpha-naphthylamine, blue; amidobenzoic acid, brown; parasulphanilic acid, red; orthotoluidine, green; an ammoniacal solution of aniline, violet, etc.

The cobalt salts, too, are adapted for photographic reproductions. The solution best adapted for the purpose is made by dissolving cobaltic hydroxide in a concentrated solution of oxalic acid. Paper sensitized with this solution is green. On exposure all parts affected by light acquire a rose-red color.

The print may be developed either as a positive or as a negative, according to the developer used. For instance, after exposure under a positive, if the print is developed with a solution of hematoxylin, a red positive is obtained; benzidine, toluidine and their hydrochlorides yield deep blue prints, changed by ammonia into brown, and by hydrochloric acid into pale black.

If it be desired to develop the reduced or light-affected parts the print is first immersed in a 5 per

long as it is kept in the dark, but on exposure to light the diazo group is liberated and immediately reacts with the amine or phenol present, and an azo color develops on the paper to which such a mixture is applied. Of course, this process gives a positive only when the negative is printed from.

The sensitizing of paper must be accomplished by means of a suitable machine in order to enable a perfectly uniform coating to be applied—and uniformity of application is absolutely essential, particularly in the case of the black print paper, in order to obtain a paper that will print evenly throughout. In an experimental way small pieces may be sensitized by hand, with certain precautions, but fine prints must not be expected, because contact of the sensitizing solution with one part of the paper for a second or two longer than with another part will give the former part more time for a greater quantity of solution to be taken up by the paper; and this will cause one part to be over-

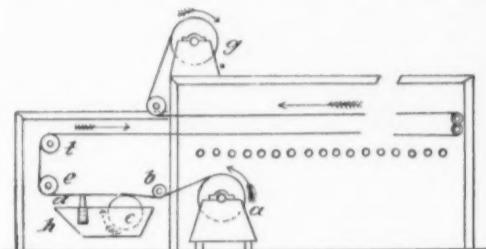


FIG. 2.

printed on exposure, whereas that more heavily charged may not be sufficiently printed.

To sensitize small pieces by hand, the best way to proceed is as follows: Cut the paper into strips from 3 to 8 inches wide (a greater width will be difficult to handle), and about 30 to 36 inches long. Pour the filtered sensitizing solution into a square, shallow dish, one side of which must have a perfectly smooth, level edge. Now take hold of the strip of paper at the two ends and allow it to hang in the form of a festoon, then let the lower surface of the paper just touch the surface of the liquid and pass it along, managing so that the entire surface of the paper comes into contact with the liquid and without any air bubbles being between them; care must be taken that no liquid comes over the edges onto the back of the paper. This feat can be readily accomplished after a little practice. As soon as the entire length of paper has been charged with liquid, bring one end of the charged surface of the paper squarely down on the smooth, level edge of the dish, taking care that the paper is in perfect contact throughout, and then slowly draw it along the edge, exerting a sufficient pressure by stretching the paper to uniformly scrape off the excess of liquid. The strip may then be hung up to dry.

Commercially, there are two types of machines in use for sensitizing paper, both operating practically upon the same principle. In Fig. 1 is shown the machine used chiefly on the Continent. In this the framework is of iron. The roll of paper, *a*, to be sensitized, is placed on its bearings, and the paper led over an arc-shaped sheet of zinc, *b*, to afford the necessary friction and keep the paper smooth; it then passes under the roller, *c*, and over *d*. From this the paper is taken up and carried over an endless felt belt, stretched over the rollers, *e* and *f*, whence it passes through a narrow slit into a long closed chamber 10 to 20 feet in length, wherein it is dried, and on its issuing is led back to the machine, where it is wound up on the roller, *g*. The bottom of the drying chamber is made of sheet iron, and is heated by Bunsen burners, or coils of steam pipe are laid inside the chamber. The vapor-charged air within the chamber is removed by means of an exhaust fan or blower.

The paper, while passing around the roller, *c*, becomes charged with the sensitizing solution which is applied by the roller, *h*. This roller is made to revolve toward the paper, and dips into the sensitizing solution contained in the trough, *i*. At a convenient place between the rollers, *c* and *d*, is fastened the scraper, a sheet of glass, one edge of which is beveled and which is held in a frame pivoted to the iron frame of the machine. The scraper may be applied against the paper with more or less pressure, and at the angle best suited for securing the best results. In some machines, wheels, *k*, with rubber tires, are placed at

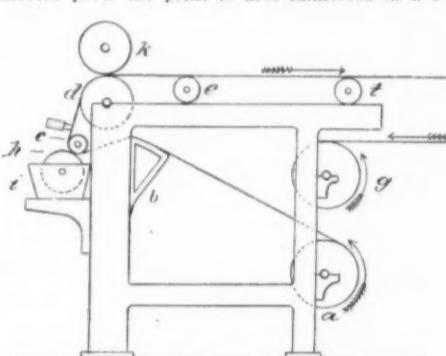


FIG. 1.

cent solution of potassium ferricyanide, and then thoroughly washed in water to remove all the unchanged cobalt salt from the paper. The print thus made has a pale red color, which is converted into more intense and different colors by various substances. For instance, on treatment with an alkali-sulphide compound, the cobalt ferricyanide on the paper is converted into cobalt sulphide. If an iron salt be used, a blue color results; with nickel salts, a red print is produced, etc.

In addition to the processes previously described may be mentioned also the process invented by Messrs. Green, Cross and Bevan, in 1890, and known generally as the "Primuline" or "Diazotype" process. It, too, affords positives from positives, the prints being producible in various colors, according to the developer employed.

This process depends upon the fact that when primuline (the sodium sulphonate of a complex amido base, obtained by heating paratoluidine with sulphur) is diazotized, it affords a diazo compound which is not only very sensitive to light, but is capable of affording a number of color reactions with various amines, phenols, etc.

The process is carried out as follows: The fabric (paper, cloth, silk, etc.) is dyed in a hot solution of primuline (15 or 30 grains to the gallon), then washed in cold water, and then immersed for about half a minute in a 0.25 per cent solution of sodium nitrate strongly acidulated with hydrochloric or other acid. The fabric so treated is again washed in cold water and dried, when it is ready for printing. The exposure takes place under a positive, and when complete the print is developed in the color desired by using the proper developer, usually in weak (about 0.25 per cent) solution. The following colors are obtained by using the developers, all in alkaline solution: Beta-naphthol, red; betanaphthol disulphonic acid, maroon; phenol, yellow; alpha-naphthylamine hydrochlorate, purple; with elkonogen in neutral or slightly acid solution, blue to black.

In another process patented more recently by A. Feer, diazo compounds are treated with an alkali bisulphite and are thus converted into diazo-sulphonates. These compounds are sensitive to light, the action of which is to set free the diazo group from its combination, but they give no reaction with amines or phenols as do the diazo compounds. Hence the mixture of a diazo-sulphonate with the latter remains uncolored so



FIG. 3.

each end of the roller, *d*, and are operated so as to draw the paper along at its edges, until it has been taken up by the roller, *g*, when the wheels are lifted from the paper. Of course, the paper will show where these wheels passed over it.

The machine shown in Fig. 2 is constructed of wood. The writer has operated both kinds of machines, and prefers the latter, which he considers much the better of the two. In this machine the roll of paper is borne by a carrier sliding in grooves or on rails. The paper is first passed under a tension roller, is then sensitized by the roller, *c*, the excess of liquid being scraped off by the glass scraper placed at *d*; it next passes over the rollers, *e* and *f*, to the end of the machine (which may be 20 or 30 feet long, or any convenient length)

where it passes over two rollers and returns to be wound up on the roller, *g*. The paper in its passage through the length of the machine is supported by a criss-cross of string stretched from side to side, in order to prevent too much sagging, and yet allow the paper to be thoroughly dried by the coil of steam pipes placed beneath it.

The rolls of paper as ordinarily received are of varying widths, 30, 36, 42, 48 inches, etc., and contain usually several hundred yards. The paper is wound on a wooden cylinder, with a hole, either square or round, running lengthwise through it. The roll of paper is supported in its carrier by thrusting through the hole in the wooden cylinder a long iron rod each end of which is threaded, but in contrary directions. After the rod is in place a tapering nut with hexagonal or octagonal head, Fig. 3, is screwed down on each end. The conical parts of the nuts enter the holes in the ends of the wooden cylinder, and on being screwed up tight, the roll is centered and held firmly. The rod bearing the roll is now placed in the bearings of the carrier. The rod is threaded oppositely at the ends because otherwise one of the nuts would invariably become loose by revolving in the direction in which the paper is pulled. As it is, it is safest to always use an additional ordinary nut which is screwed down on each conical nut when the latter has been firmly fixed in place.

The sensitizing liquid is contained in a trough, *h*, which is preferably made of hard rubber. Galvanized zinc, however, is coated with shellac first, and when dried with an asphalt solution, answers also. The sensitizing roller may be either of hard rubber or wood covered with felt or canton flannel. The scraper may be a sheet of glass about 3 or 4 inches wide, and as long as the width of the machine. It is well to have both of the long edges cut accurately straight and rounded and free from nicks. This is, however, a point difficult to attain, hence the author has made use of glass tubing, which may be had perfectly straight and round; this gives the best results. The sheet of glass may be supported in a frame of wood in which it may be easily held perfectly tight, yet which allows the excess of liquid scraped off the paper to freely trickle down into the trough. If the glass tubing is used it shou'd be cemented into a frame, one edge of which has been hollowed out to receive it.

When very or even moderately thin paper is sensitized, the moistening of the paper allows it to stretch considerably; and the stretching occurs most at the middle of the paper. The result of the stretching is to cause a crinkling of the paper as it passes over the rollers, *e* and *f*, and longitudinal creases form which totally spoil the paper. This is obviated by replacing *e* and *f* by rollers which are not cylindrical, but which are thicker in the middle than at the ends; and the thinner the paper the thicker must the rolls be in the middle as compared with the ends.

The paper is started on the machine by first winding a couple of hundred yards of heavy manila paper on the roll, *g*, and then carrying the end of this paper through the length of the machine and back again to about the place shown at *k*. Here the paper drawn from the roller, *a*, meets it, and the two are pasted together. The paper is then run back until it is but a few inches in front of the sensitizing roller.

Power is supplied at *g*, and a speed of about 100 yards per hour is given to the paper. The power must be steady and even, and must absolutely impart no vibration to the machine; otherwise, a series of transverse parallel lines will become visible on the paper when dry—due to the fact that the liquid remained in contact for a fraction of a second longer on one spot of the paper than it did on another, and the liquid will have soaked into the paper so much the more the longer the contact. The utmost care must be observed that no solid particles of matter settle in the angle formed by the scraper and the paper, for, when this happens, the paper is partially lifted from the scraper, and a long longitudinal streak caused by an excess of sensitizing liquid will result.

The form of machine last described has the advantage in that the top may be used as a table. The sides may be screened with oilcloth or other material, thus rendering every part of the machine and paper, easily accessible, which is very important, as sometimes the paper does not run perfectly true, because of faulty winding-up on its spool, stretching more on one side than on the other, faulty alignment, etc. Furthermore, the operator has always before him the freshly sensitized paper as it leaves the scraper, and by reason of the arrangement is enabled to watch over the details, by a close study of which alone is the sensitizing of paper, even with a well-constructed machine, rendered perfectly successful. It need scarcely be mentioned, of course, that all movable parts of the machine must run easily and freely and without a jar, and all the bearings kept well oiled and free from dirt.

#### NEW FILTER PLANT AT MIDDLETOWN, N. Y.

THE city of Middletown, which is located in the heart of the famous and historic Orange County of New York, has long been noted for its general healthfulness, and the thrift and enterprise of its citizens. Situated as it is 565 feet above sea level, it enjoys pure and bracing air and a water supply which, though naturally superior is further improved by filtration. Recognizing the vital importance of obtaining a generous supply of pure water, this city with characteristic energy has, in the last dozen years, made a study of its water system, which has recently culminated in the construction of a new reservoir and a filter plant. The city's present source of water supply consists of streams, springs, watersheds and artesian wells, the water being stored in two large reservoirs, namely, the Monhagen reservoir, holding 296,000,000 gallons, and the new Highland reservoir, with a capacity of 560,000,000 gallons. These two are connected by a 12-inch iron conduit, which conducts the water to the city. Before reaching the city, however, the water is first filtered under pressure.

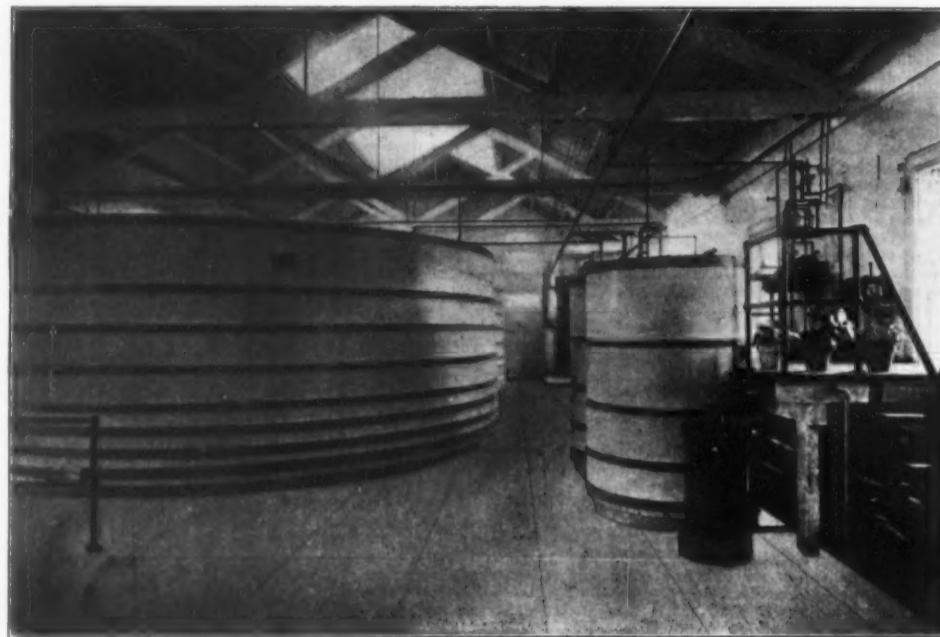
The filter plant, which is nearly completed, has cost about \$30,000. It consists of a gravity filter plant, having a capacity of 2,000,000 gallons daily, and a

pressure filter plant with 1,000,000 gallons daily capacity, all being located in a building under which is the pure water reservoir. The pressure plant comprises four steel tanks, 8 feet in diameter and 10 feet long. Each tank, which is provided with the usual number of inlet and outlet valves, is equipped further with a manifold of wrought-iron pipe with strainer cups, and an internal manifold of brass and galvanized-iron pipes for the purpose of distributing the air used in washing the filters. In connection with the pressure system is an aerating device, to allow aeration of the water before entering the filter plant. Each filter

and their authors, with the result that some strange and little known facts have been brought to light.

Who, for instance, knows anything about Dover, who immortalized himself by discovering "Dover's powder," which is in daily use in many countries of the world and is a regular stand-by? Many people had supposed that this worthy lived in comparatively recent times and that he belonged in the category with Bright, of "Bright's disease" fame; Murphy, the discoverer of "Murphy's button," and McBurney, after whom "McBurney's point" is named.

The singular fact, however, has been brought to



INTERIOR OF FILTER HOUSE.

contains 42 inches of sand. The gravity plant consists of two subsiding basins and four filters, each filter having a capacity of 500,000 gallons daily. The subsiding basins are wooden tanks built of 3-inch cypress, each 22 feet in diameter and 7½ feet deep inside. The filter tanks are built of 2½-inch cypress, 15 feet in diameter and 7 feet deep. These filters also have each a manifold of iron pipes with strainer cups, and an internal manifold of brass and galvanized-iron pipes for the distribution of air, and contain each a layer of sand 36 inches deep. A suitable metal gutter around the periphery of each tank is employed for distributing the applied water and for removing the waste water during washing. Automatic valves regulate the flow through the inlet and outlet pipes of the subsiding basins and filters. A 75 horse power boiler, wash-water pump, blowing engine and the usual chemical devices, feed pumps, etc., are provided, as are also necessary piping, drains, etc. The total

light that Dover was not only the author of one of the earliest "roasts" on the Royal College of Physicians, but that he discovered Alexander Selkirk on the Island of Juan Fernandez and brought him away. At least that is what the Chemist and Druggist says.

Out from some dust heap of the past there has been fished Thomas Dover's sole contribution to literature. It was published in 1732, when he was past seventy years of age, and bore the following title:

"The Ancient Physician's Legacy to his Country—Being what he has collected himself in Forty-nine Years' Practice. Or an Account of the Several Diseases incident to Mankind described in so plain a Manner that any Person may know the Nature of his own Disease. Together with the several Remedies for each Distemper faithfully set down. Designed for the Use of all Private Families." Herein Dover's famous formula was contained.

Dr. Dover felt that he had a message to deliver, and



GRAVITY FILTERS OF THE FILTER HOUSE.

#### FILTER PLANT OF MIDDLETOWN'S WATER SYSTEM.

amount of water filtered daily has averaged about 1,500,000 gallons, and the cost of maintenance is estimated at about \$3300 per year.

#### THE INVENTOR OF DOVER'S POWDER.

SINCE Mark Twain at a recent dinner in this city went into the subject of old-time physicians and their methods, says the New York Times, an investigation has been carried out in England into the ancient cures

he had but little faith in the "clan of prejudiced gentlemen," as he termed the Royal College of Physicians. They returned his contempt, or, more probably, they began the squabble, for Dover tells in his book that they had referred to him in derision as "the quicksilver doctor." But it was a title in which he gloried. He had immense faith in quicksilver, "this precious jelly of metals, as it may be called." It makes a "pure balsam of the blood," he says. "You all give it," he adds, "but you disguise it. I give it in an honest, open manner. You give it combined with

sulphur, the worst excipient you could find, in the form of Ethiop's mineral. That is like striking a man with a sword in a scabbard."

"Their opinion is a sign they have traveled far at home." He advises them to "take a trip to Hungary and visit the mines where the quicksilver is dug. They may there see slaves working entirely naked to prevent them stealing the metal." But these slaves, it appears, dodged their taskmasters by swallowing every day so much that they buy a choppin of drink with it at night.

Dover was born somewhere in Warwickshire in 1660. How he got his medical training is not known, but some time in his youth he lived in the house of the famous physician Sydenham. There he had smallpox, and his treatment is worth recording. First he was bled to the extent of twenty-two ounces, and then he had an emetic. It was January; he had no fire in his room, the windows were always kept open, and the bedclothes were only allowed up to his waist. The medicine he took was twelve bottles of small beer, acidulated with spirit of vitriol every twenty-four hours.

Having resisted both the disease and the treatment, he is first heard of in practice at Bristol in 1684. He plodded on there till 1708, when at the age of forty-eight he set out with a privateering party on a voyage round the world. They had two ships, the "Duke" and the "Duchess." Capt. Woodes-Rogers, who has left an account of the expedition, was in chief command, and Dover, who had charge of the "Duke," was his second. He must have been on the sea in his early life, or he would hardly have been chosen to command a vessel. The buccaneers were away from England three years, and they came back with a Spanish frigate of twenty-one guns and lots of loot.

Among the other events of the voyage was one of world-famous importance. On February 2, 1709, Dover touched at the island of Juan Fernandez, and brought away from it Alexander Selkirk, who had been there alone four years and four months, and who was the prototype of the immortal Robinson Crusoe.

A few months later the expedition landed at Guaya-

"In two or three hours at furthest the patient will be free from pain; and, though before not able to put his foot to the ground, 'tis very much if he cannot walk next day. The remedy may be taken once a week or once a month."

A sidelight on the relations between doctors and apothecaries in the early days of the eighteenth century is thrown by Thomas Dover's treatise. In a chapter onague (for which he says bark is the best medicine known to mankind, though he wishes he could have the resinous quality of it separated from the earthy part) he remarks that he cannot prescribe to please the apothecaries. He cannot "bring a fever case to £3," though he has known apothecaries who have run up their bills in such cases to £40, £50 or £60. Every time a physician writes, he says, it is supposed to put 10s, or 12s. in the apothecary's way. Then as a postscript, he prints the following on the last page:

"N. B.—Having taken notice of some errors in the practice of other physicians, I shall frankly own one in my own; I have hitherto been too zealous in recommending one particular apothecary, but am resolved for the future to let all my patients make use of any apothecary they like best, which I think is but doing justice to the gentlemen of that profession."

Whether this was a really honest repentance, or whether the one particular apothecary had offended Master Dover, did not appear.

#### THE GULF STREAM MYTH.

ABOUT thirteen years ago, a writer in *The Sun* summarized the evidence collected by the leading oceanographers of the day with regard to the course of the Gulf Stream in the Atlantic and the alleged effect of this current upon the climate of western Europe. The quotations in that article from such scientific leaders as Carpenter, Buchanan, Alexander Agassiz, Findlay, Thoulet and others clearly showed that all the evidence collected from the time of the "Challenger" soundings pointed unmistakably to the disappearance of the Gulf Stream as a distinct, trace-

science as to the causes of the mild climate of western Europe. The recent publications of the Deutsche See-warte of Hamburg, devoted to hydrography and marine climatology, and those of the British Hydrographic Office, have left the Gulf Stream myth nothing to stand upon.

The latest and one of the most valuable contributions to this subject is an article in the current number of *Scribner's Magazine* on "The Gulf Stream Myth and the Anti-Cyclone," by Harvey M. Watts of Philadelphia—an article that is not only scientific but also written in a manner to interest and edify unscientific readers. Mr. Watts is one of the increasing number of writers who are showing that a scientific topic may be adequately treated without being garbed in an unattractive literary dress. The article gives the history of the origin and promulgation of the belief that the Gulf Stream is the sole cause of the mild oceanic climate of western Europe. The writer shows how completely this theory failed to grasp the profound influence of the drift of the atmosphere in determining the nature of weather and climate. It is not sea current, but the prevailing air current blowing from the Atlantic to the lands of Europe that gives a genial character to the climate of those far northern regions.

It would be to the advantage of most teachers of geography to read and study so clear an exposition as this article gives of our present knowledge of the laws of atmospheric circulation and the effect of these air currents in different parts of the world.

The gist of the whole matter, as far as it relates to the climate of western Europe, is that "since the atmospheric drift in the temperate zones is from west to east, this means that all coasts and countries to the east of oceans have transferred to them oceanic ameliorations, while the eastern parts of continents naturally receive the atmospheric drift as affected by the land masses over which it has traveled."

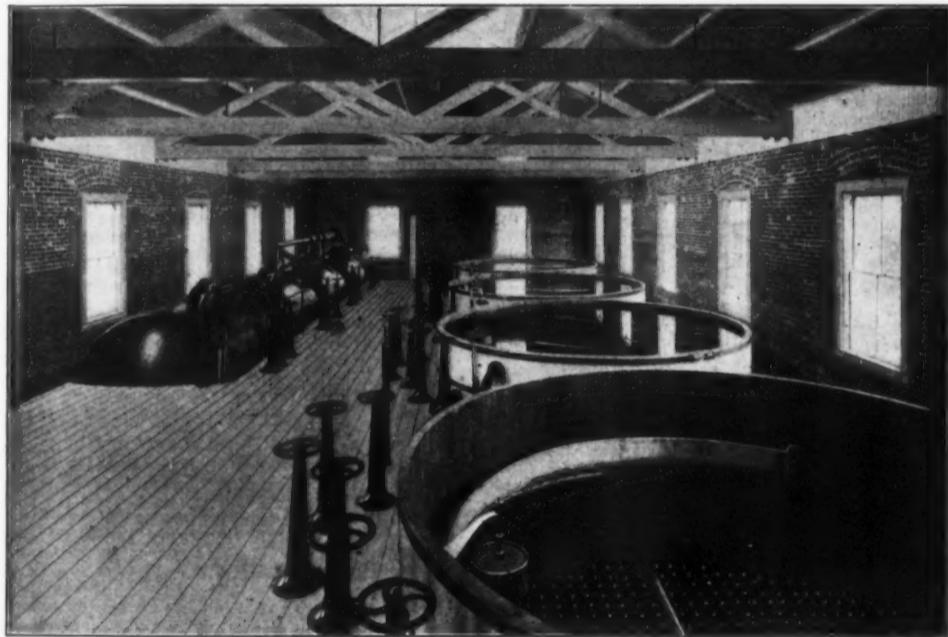
This is the reason why England has a mild climate and fifty little ports of Norway are open all winter: the influence of the mid-Atlantic basin is carried by the air to the west coast regions of Europe, giving them their oceanic climate; while Labrador, no farther north, receiving the air currents of Arctic and subarctic America and not of the ocean, is frigid. When it had been fully demonstrated that the Gulf Stream theory was a delusion it would not have been possible to show so clearly as Mr. Watts has done in his able article the meteorological causes that determine the difference between the climates of England and Labrador. The modern belief is summed up in a few paragraphs which Mr. Watts quotes from Prof. Abbe, a part of which are given here:

"The circulation of air in the northeastern part of the Atlantic Ocean determines the mild character of western Europe by distributing the moisture and warmth of the Atlantic Ocean surface as a whole and not that of the Gulf Stream, since there is no apparent Gulf Stream in these latitudes."

"The warmth of the southwest winds of Europe is due to the moisture they contain, which gives up its latent heat when it becomes cloud and rain. The winds take up this moisture from the surface of the ocean when the latter is warmed up by the sunshine and they would do the same if there were no Gulf Stream in the Straits of Florida."—*New York Sun*.

#### LIGHT AND MALARIA.

THE demonstration of the plasmodium as the *vera causa* of malarial fevers and the successive sporulations of the parasite as the exciting causes of paroxysms have exploded many popular and traditional beliefs and have explained those that experience has established as to the conditions under which these diseases prevail and the means by which they may be prevented, as being simply such as are most favorable to the multiplication of the anopholes and such as tend to its extermination. But there are still some facts hitherto unexplained pointing to conditions connected with solar phenomena, and not unnaturally ascribed to the sun's heat as the most obvious and palpable of these. But it is not easy to imagine how the parasite can be influenced by external temperatures, since it is itself in a medium, the blood, which is not affected thereby, the pyrexia of the paroxysm being the effect, not the cause, of its intermittent activity. In the *American Journal of the Medical Sciences* for February, Dr. A. F. A. King, of New York, puts forward an ingenious suggestion that the actual factor in question is the light, not the heat, of the sun, and that the relative immunity of the very dark and black races of man is due to the lesser translucency of their skins. Celli and Tacchini had noticed that the years in which the fevers were most severe in Italy were by no means the hottest, though the number of cloudy days was above the average. Jackson remarked that in Jamaica a camp over which a fog hung all day suffered less than did those apparently better situated, and the beneficial effects of several days of heavy rain have often been noticed. Flint states that paroxysms very rarely occur at night and that, recurring some hours later each successive day, when they fall after dark they are usually deferred to the following morning, when they may sometimes be avoided by the patient lying in bed through the day. The experiments of Harrington and Leamington on the common ameba lend considerable support to this hypothesis, for they found that the ameba "streamed" under the influence of bright sunshine, but still more actively when exposed to red light, whereas the process was arrested in the darkness and was completely inhibited by the violet and ultra-violet rays. Since the skin of all but the blackest races, and especially that of white men, is more or less translucent, it is evident that blood parasites may be susceptible to the influence of the light of the sun, though protected by the constant heat of the body from that of external temperature, and that it is chiefly the red rays that can reach them through the medium of the blood. Until it shall have been proved that the blood of the negro is darker than that of the white man, and that the color of the latter can be perceptibly altered by practicable dosage with methyl blue or can be made fluorescent by the administration of



PRESSURE FILTERS OF FILTER HOUSE.

FILTER PLANT OF MIDDLETON'S WATER SYSTEM.

quill, in Peru. Having sacked the city and stored their plunder in the ships, the sailors slept in the churches, and Dover records quaintly how they were annoyed by the smell of the corpses. For plague was raging in the place at the time, and the victims were laid just below the floor, with only a plank or two to cover them. Forty-eight hours later, after they had again put to sea, a large number of the sailors were attacked by the disease. One hundred and eighty of them altogether had it.

Dover, who had four surgeons under him, ordered them to be bled freely, and he says about 100 ounces of blood was taken from each man. The surgeons went round and started the bleeding, and only stopped it when they had made their rounds. Then he gave them spirit of vitriol, and only seven or eight died.

Returning to England, Dover practised in Cecil Street, London, till 1728, when he is again missed for two or three years. From 1731 to 1736 he lived in Arundel Street, Strand. There he wrote his book, in the preface of which he quotes Dr. Radcliffe's opinion that it is expedient that young gentlemen entering our profession should travel. "If traveling be necessary to make an accomplished physician," Dover remarks, "I am very sure that I have traveled more than all the physicians in Great Britain put together."

His diaphoretic powder is prescribed in his book in a chapter on gout. The formula differs, but the resulting compound is practically the same thing that is called Dover's powder. The original formula was as follows:

"Take opium 1 ounce, saltpeter and tartar vitriolated each 4 ounces, liquorish 1 ounce, ipecacuanha 1 ounce. Put the saltpeter and tartar into a red-hot mortar, stirring till they have done flaming. Then powder them very fine; after that slice in your opium; grind these to a powder, and then mix the other powders with these. Dose: From 40 to 60 or 70 grains in a glass of white wine posset going to bed, covering up warm, and drinking a quart or three pints of the posset-drink while sweating."

able current a little to the southeast of Newfoundland. Oceanographers had proved in fact that the Gulf Stream ceases to exist before reaching the mid-Atlantic; and having settled this question beyond all doubt they naturally began to combat the idea, promulgated by that gifted scientific writer, Lieut. Maury, a half century ago, that it was the Gulf Stream which, crossing the Atlantic, warmed the western coast of Europe and kept the harbor of Hammerfest, within the Arctic Circle, free from ice.

Some text books, still used in our schools, assert that northwest Europe would be a howling Arctic waste if it were not for the genial influences brought to its shores by the warm Gulf Stream. This fact illustrates the persistency of error when once universally accepted as truth, and powerfully impressed upon the popular imagination. The *Proceedings of the Royal Geographical Society* predicted, ten or twelve years ago, that "it will probably take a generation or two to eradicate the old erroneous notions of text books and popular treatises concerning the Gulf Stream." The present prospects, happily, are that it will not take more than a generation after the scientific revolt against Maury's baseless theory began to enlighten the text-book writers and disillusionize the school teachers.

In none of the best reference books, atlases and maps of to-day is the Gulf Stream represented as extending to the European coast. The truth discovered by the oceanographers that the stream disappears in midocean is being spread abroad with powerful iteration and emphasis. The actual causes of the mild climate of western Europe, discovered through the accumulation of proven facts in the domain of meteorology, are having wider and wider circulation through popular as well as scientific publications. A few months ago, the *Monthly Weather Review*, published by our government and edited by Prof. Cleveland Abbe, one of the leading meteorologists, contained an able article exposing the fallacies of the old Gulf Stream theory and giving the conclusions of modern

quinine, we must forbear following Dr. King in his speculations on these points, but we think that he has made out a fair case for his light theory and for the trial of what may be called "seco-therapy" in the treatment of malarial fevers—that is, of keeping the patient in a dark room and in the intervals between the attacks of clothing him in garments with linings impenetrable by light.

#### RECENT PROGRESS IN AMERICAN BRIDGE CONSTRUCTION.\*

By PROF. HENRY S. JACOBY, Cornell University.

In view of the great achievements in engineering construction which characterized the latter part of the nineteenth century in America, it seems appropriate to give a brief review of the most recent progress in one of its departments, that of bridge construction. It appears to be the more fitting since the place of this meeting of the Association is the greatest center of production of the material which constitutes the bulk of that used for modern bridges.

The application of scientific principles to the construction of bridges is more complete to-day than ever before. This statement applies to the specified requirements which the finished structure must fulfill, the design of every detail to carry the stresses due to the various loads imposed, the manufacture of the material composing the bridge, the construction of every member in it, and finally the erection of the bridge in the place where it is to do its duty as an instrument of transportation.

A close study of the economic problems of transportation in the United States and the experimental application of its results led the railroad managers to the definite conviction that, in order to increase the net earnings while the freight rates were slowly but steadily moving downward, it was necessary to change the method of loading by using larger cars drawn by heavier locomotives, so as to reduce the cost of transportation per train mile. While these studies had been in progress for a number of years and there was a gradual increase in the weight of locomotives, it is only within the past five years that the test was made, under favorable conditions and on an adequate scale, to demonstrate the value of a decided advance in the capacity of freight cars and in the weight of locomotives for the transportation of through freight. The test was made on the Pittsburgh, Bessemer & Lake Erie Railroad, which was built and equipped for the transportation of iron ore from Lake Erie to Pittsburgh and of coal in the opposite direction.

When the economic proposition was fairly established, it was wonderful to see how railroad managers and capitalists met the situation, by investing additional capital for the newer type of equipment, and for the changes in road bed and location necessarily involved by that in the rolling stock. Curves were taken out or diminished, grades were reduced, heavier rails were laid, and new bridges built, so that practically some lines were almost rebuilt. The process is still going on and money by the hundred millions is involved in the transformation and equipment of the railroads. Some impression of the magnitude of the change in equipment may be gained from the single fact, that one of the leading railroads has within a few years expended more than twenty millions of dollars for new freight cars alone, all of which have a capacity of 100,000 pounds. The form of loading for bridges almost universally specified by the railroads of this country consists of two consolidation locomotives followed by a uniform train load. These loads are frequently chosen somewhat larger than those that are likely to be actually used for some years in advance, but sometimes the heaviest type of locomotives in use is adopted as the standard loading. The extent to which the specified loadings have changed in eight years may be seen from the following statement based on statistics compiled by Ward Baldwin and published in the Railroad Gazette for May 2, 1902.

Of the railroads whose lengths exceed 100 miles, located in the United States, Canada and Mexico, only 2 out of 77 specified uniform train loads exceeding 4000 pounds per linear foot of track in 1893, while in 1901, only 13 out of 103 railroads specified similar loads less than 4000 pounds. In 1893, 37 railroads specified loads of 3000 pounds and 29 of 4000 pounds, while in 1901, 4000 pounds was specified by 50, 4500 pounds by 14, and 5000 pounds by 17 railroads. The maximum uniform load rose from 4200 in 1893 to 6600 pounds in 1901.

In a similar manner in 1893 only 1 railroad in 75 specified a load on each driving wheel axle exceeding 40,000 pounds, while in 1901 only 13 railroads out of 92 specified less than this load. In 1893 only 21 of the 77 railroads specified similar loads exceeding 30,000 pounds. The maximum load on each driving wheel axle rose from 44,000 pounds in 1893 to 60,000 pounds in 1901.

The unusual amount of new bridge construction required caused a general revision of the standard specifications for bridges, the effect of which was to include the results of recent studies and experiment, and to eliminate some of the minor and unessential items formerly prescribed.

Meanwhile another movement was in progress. Experience having shown the great advantage of more uniformity in various details and standards relating to the manufacture of bridges both in reducing the cost and the time required for the shop work, an effort was begun to secure more uniformity in the requirements for the production and tests of steel, which is the metal now exclusively employed in bridges.

The American Section of the International Association of Testing Materials is bringing together through its investigations and discussions a mass of selected information on the relations of chemical composition, heat treatment, mechanical work, etc., to the physical properties of steel as well as of other metals used in structures and for mechanical purposes.

The thorough digest of these results of scientific research and practical tests, and the preparation and

adoption of standard specifications for different classes of material, are confidently expected to eliminate many old requirements which are proved inefficient in securing the results for which they were originally intended, and to incorporate in the specifications only the essential requirements by which the character of the product may be determined with sufficient precision for its actual duty. By making these requirements reasonable and fair, on the one hand as simple and definite as possible without impairing their real value, and on the other hand flexible enough to avoid imposing undue hardship upon the manufacturer who keeps in touch with the best methods available, the result is confidently expected to be a high degree of interested co-operation on the part of both engineer and manufacturer in securing the best grade of material which the present state of science makes practicable.

The American section of that association in 1901 adopted a series of proposed standard specifications, one of which relates to steel for bridges and buildings and which is recommended for adoption by those who buy such structures. A committee of the Railway Engineering and Maintenance of Way Association is now at work on the same problem, a full agreement having not yet been reached.

With greater uniformity in the physical, chemical and other requirements for steel, as determined by standard tests, the unit stresses to be prescribed for the design of bridges will naturally approach to a corresponding uniformity. To what extent this is desirable may be inferred from the fact that the application of several of the leading specifications to the design of a railroad bridge under a given live load yields results which may vary by an amount ranging from zero to twenty-five per cent of the total weight.

In the revision of specifications a decided tendency is observed to simplify the design by making an allowance for impact, vibration, etc., by adding certain percentages to the live load according to some well-defined system. It needs but relatively little experience in making comparative designs of bridges under the same loading, to show the advantage of this method over that in which the allowance is made in the unit stresses according to any of the systems usually adopted in such a case. Not only are the necessary computations greatly simplified, but the same degree of security is obtained in every detail of the connections as in the principal members which compose the structure.

Experiments on a large scale are very much needed to determine the proper percentage of the live load to be allowed for the effect of impact, so as to secure the necessary strength with the least sacrifice of true economy. While the extreme economy of material that was formerly practised is not now desirable, since stiffness receives due consideration, some idea of the importance of such an investigation may be gained by considering the magnitude of the industries involved.

In March, the Railroad Gazette published a supplement containing a list of bridge projects under consideration. This list was intended to include only the larger steel and stone structures, whether for railroads or highways, the aim being to exclude those that are obviously unimportant. Besides this, the bridges needed on the 1500 new railroad projects recorded in the same supplement are likewise excluded. After excluding both of these classes the list still contains about 1300 new projects for bridges.

An investigation might also be advantageously made to determine the proper ratio of the thickness of cover plates in chord members which are subject to compression, to the transverse distance between the connecting lines of rivets. The same need exists in regard to the stiffening of the webs of plate girders, concerning which there is a wide variation in the requirements of different specifications.

A movement which has done much good during the past decade and promises more for the future is that of the organization of bridge departments by the railroad companies. The great economy of making one design rather than to ask a number of bridge companies to make an equal number of designs, of which all but one are wasted, is the first advantage; but another of even greater significance in the development of bridge construction is that which arises from the designs being made by those who observe the bridges in the conditions of service and who will naturally devote closer study to every detail than is possible under the former usual conditions. The larger number of responsible designers also leads to the introduction of more new details to be submitted to the test of service, which will indicate those worthy of adoption in later designs. In order to save time and labor and secure greater uniformity in the design of the smaller bridges, some of the railroads prepare standard plans for spans varying by small distances. For the most important structures consulting bridge engineers are more frequently employed than formerly, when so much dependence was placed upon competitive designs made by the bridge companies.

An investigation was recently made by a committee of the Railway Engineering and Maintenance of Way Association in regard to the present practice respecting the degree of completeness of the plans and specifications furnished by the railroads. It was found that of the 72 railroads replying definitely to the inquiry, 33 per cent prepare "plans of more or less detail, but sufficiently full and precise to allow the bidder to figure the weight correctly and if awarded the contract to at once list the mill orders for material"; 18 per cent prepare "general outline drawings showing the composition of members, but no details of joints and connections"; while 49 per cent prepare "full specifications with survey plan only, leaving the bidder to submit a design with his bid." If, however, the comparison be made on the basis of mileage represented by these 72 railroads, the corresponding percentages are 48, 24 and 28 respectively. The total mileage represented was 117,245 miles. A large majority of the engineers and bridge companies that responded were in favor of making detail plans.

The shop drawings, which show the form of the bridge, the character and relations of all its parts, give the section and length of every member, and the size and position of every detail whether it be a reinforcing plate, a pin, a bolt, a rivet or a lacing bar.

All dimensions on the drawings are checked independently so as to avoid any chance for errors. The systematic manner in which the drawings are made and checked, and the thorough organization of every department of the shops, make it possible to manufacture the largest bridge, to ship the pieces to a distant site and find on erecting the structure in place that all the parts fit together, although they had not been assembled at the works.

The constant improvement in the equipment of the bridge shops, and the increasing experience of the manufacturers who devote their entire time and attention to the study of better methods of transforming plates, bars, shapes, rivets and pins into bridges, constitute important factors in the development of bridge construction.

As the length of span for the different classes of bridges gives a general indication of the progress in the science and art of bridge building, the following references are made to the longest existing span for each class, together with the increase in span which has been effected approximately during the past decade.

In plate girder bridges the girders, as their name implies, have solid webs composed of steel plates. A dozen years ago but few plate girders were built whose span exceeded 100 feet, the maximum span being but a few feet longer than this. To-day such large girders are very frequently constructed, and the maximum span has been increased to 126 feet between centers of bearings. This is the span of the large plate girders of the viaduct on the Riverside Drive in New York city, erected in 1900. The longest railroad plate girder was erected about the same time on the Bradford Division of the Erie Railroad, its span being 125 feet 2½ inches. The heaviest plate girder is the middle one of a four-track bridge on the New York Central Railroad erected last year near Lyons, N. Y. Its weight is 103 tons, its span 107 feet 8 inches, and its depth out to out 12 feet 2 inches.

The large amount of new construction and the corresponding increase in the weight of rolling stock have combined to secure a more extensive adoption of plate girders and the designs of many new details for them. These affect chiefly the composition of the flanges, the web splices, the expansion bearings and the solid floor system. Although solid metal floors built up of special shapes were first introduced into this country fifteen years ago, their general adoption has taken place largely within the past decade on account of their special adaptation to the requirements of the elevation of tracks in cities. Solid floors may not only be made much shallower than the ordinary open type, thereby reducing the total cost of the track elevation, but they also permit the ordinary track construction with cross-ties in ballast to be extended across the bridge, thus avoiding the jar which otherwise results as the train enters and leaves the bridge, unless the track is maintained with extraordinary care.

The necessity for bridges of greater stiffness under the increased live loads has also led to the use of riveted bridges for considerably longer spans than were in use six or seven years ago. The use of pinned connections for spans less than about 150 feet is undesirable for railroad bridges, on account of the excessive vibration due to the large ratio of the moving load to the dead load, or weight of the bridge itself.

While riveted bridges are now quite generally used for spans from 100 to 150 feet, they have been employed to some extent up to 181½ feet. The recent forms of riveted trusses do not, however, conform to the general character of European designs but embody the distinctively American feature of concentrating the material into fewer members of substantial construction. With rare exceptions the trusses are of the Warren, Pratt and Baltimore types with single systems of webbing. At a distance where the riveted connections cannot be distinguished, the larger trusses have the same general appearance as the corresponding pin bridges.

The recent examples of viaduct construction with their stiff bracing of built-up members and riveted connections exhibit a marked contrast to the older and lighter structures, with their adjustable bracing composed of slender rods. The viaduct which carries the Chicago & Northwestern Railroad across the valley of the Des Moines River, at a height of 185 feet above the surface of the river is 2658 feet long. It was built in 1901, is the longest double-track viaduct in the world, provided those located in cities be excluded, and is an admirable type of the best modern construction. The tower spans are 45 feet long and the other spans are 75 feet long. Four lines of plate girders support the two tracks. Along with this viaduct should be mentioned the Viaduct Terminal of the Chesapeake & Ohio Railway at Richmond, Va., whose length, including the depot branch, is 3.13 miles. A large part of this is not very much higher than an elevated railroad in cities. The excellent details and clean lines of this substantial structure give it a character which is surpassed neither in this country nor abroad. It may be added that the highest viaduct in this country, and which was rebuilt in 1900, is located seventeen miles from Bradford, Pa., where the Erie Railroad crosses the Kinzua Creek at a height of 301 feet. It has a length of 2053 feet.

While the elevated railroads which have been built recently also embody many of the characteristics of the best viaduct construction, special study has been given to improve their esthetic effect. The use of curved brackets, of connecting plates whose edges are trimmed into curves so as to reduce the number of sharp angles, and of rounded corners of posts, constitute some of the means employed. The results are seen in the structures of the Boston Elevated Railroad and in some of the latest construction in Chicago.

The longest span of any simple truss in America is that of the bridge over the Ohio River at Louisville, erected in 1893. Its span center to center of end pins is 546½ feet. Since that time several other bridges of this kind have been built which are considerably heavier, although their spans are somewhat shorter. The most noteworthy of these are the Delaware River bridge on the Pennsylvania Railroad near Philadelphia and the Monongahela River bridge of the Union

\* Address before the American Association for the Advancement of Science, Pittsburg Meeting, June 28-July 3, 1902.

Railroad at Rankin, Pa., both of which are double-track bridges. The Delaware River bridge was erected in 1896, each one of its fixed spans having a length of 533 feet and containing 2094 tons of steel. The Rankin bridge was erected in 1900. Its longer span has a length of 495 feet 8½ inches between centers of end pins and contains about 2800 tons of steel, making it the heaviest single span ever erected. It may also be added that the locomotive and train load for which this bridge was designed is the heaviest that has yet been specified.

The recent changes in the details of pin-connected truss bridges have been mainly the result of efforts to eliminate ambiguity in the stresses of the trusses, to reduce the effect of secondary stresses, and to secure increased stiffness as well as strength in the structure. Double systems of webbing have been practically abandoned so far as new construction is concerned. The simplicity of truss action thus secured permits the stresses to be computed with greater accuracy and thereby tends to economy. Before the last decade very few through bridges and those only of large span were designed with end floor beams in order to make the superstructure as complete as possible in itself and independent of the masonry supports. Now this improved feature is being extended to bridges of small spans. Similarly dropping the ends of all floor beams in through bridges so as to clear the lower chord and to enable the lower lateral system to be connected without producing an excessive bending movement in the posts has likewise been extended to the smaller spans of pin bridges and is now the standard practice. The expansion bearings have been made more effective by the use of large rollers, and of bed plates so designed as to properly distribute the large loads upon the masonry. In the large spans of through bridges the top chord is curved more uniformly, thereby improving the esthetic appearance. These chords are also given full pin bearings, thus reducing the secondary stresses.

The stiffness of truss bridges has been secured by adopting stiff bracing in the lateral systems and sway bracing, instead of the light adjustable counter ties in the trusses are being replaced in recent years by stiff ones, while in some cases the counters are omitted and the main diagonals designed to take both tension and compression.

Some of the same influences referred to above have led to much simpler designs for the portal bracings by using a few members of adequate strength and stiffness in general character to those of the trusses.

Such steady progress in the design and construction of railroad bridges of moderate span has, unfortunately, no adequate counterpart in highway bridges. The conditions under which highway bridges are purchased by township and county commissioners are decidedly unfavorable to material improvements in the character of their details. It is a comparatively rare occurrence that the commissioners employ a bridge engineer to look after the interests of the taxpayers by providing suitable specifications, making the design, inspecting the material, and examining the construction of the bridge to see that it conforms to all the imposed requirements. These provisions are only made in some of the cities, and accordingly, one must examine the new bridges in cities to learn what progress is making in highway bridge building.

The lack of proper supervision in the rural districts and many of the smaller cities results in the continued use of short trusses with slender members built up of thin plates and shapes, whose comparatively light weight causes excessive vibration and consequent wear, as well as deterioration from rust. Under better administration plate girders would be substituted for such light trusses, making both a stiffer structure and one more easily protected by paint. The general lack of inspection and the consequent failure to protect highway bridges by regular repainting will materially shorten their life and thereby increase the financial burden to replace them by new structures. Some progress has been made by adopting riveted trusses for the shorter spans for which pin-connected trusses were formerly used, but the extent of this change is by no means as extensive as it should be, nor equal to the corresponding advance in railroad bridges.

The channel span of the cantilever bridge over the Mississippi River at Memphis, Tenn., is the longest one of any bridge of this class in America. It measures 790½ feet between centers of supports. This bridge was finished in 1890, the same year that marked the close of the seven-year period of construction and erection of the mammoth cantilever bridge over the Firth of Forth in Scotland. A number of cantilever bridges have been built since then, but most of them have comparatively short spans. There is one now under construction over the Monongahela River in Pittsburgh, and which is expected to be finished this year, whose span is to be a little longer than that of the Memphis bridge. It is on the new extension of the Wabash Railroad system, and the distance between pier centers is 812 feet.

But there is another one being built which will not only have a longer span than any other cantilever bridge in this country, but longer than that of any other bridge whatsoever. It is located near Quebec, Canada, and its channel span over the St. Lawrence River is to have the unprecedented length of 1800 feet, or nearly a hundred feet longer than that of the Forth cantilever bridge and two hundred feet longer than the Brooklyn suspension bridge. The towers will have a height of 360 feet above high tide. It will accommodate a double-track railroad, besides two electric railway tracks and highways. In the piers the courses of masonry are four feet high and individual stones weigh about fifteen tons each. The character of its design and the simplicity of its details will permit its construction with unusual rapidity and economy for a bridge of this magnitude. Several other cantilever structures whose largest spans range from 600 to 671 feet are either now or soon will be under construction.

The Brooklyn bridge, completed in 1883, is still the largest suspension bridge in the world, its span being 1595½ feet. More people cross this bridge than any other in any country. The New East River

bridge, which is now being built, has a span of 1600 feet, and its capacity will be very much greater than that of the Brooklyn bridge. Each of its four cables has a safe strength of over 10,000,000 pounds in tension.

One of the most interesting developments relating to the subject under consideration is the construction of a considerable number of metallic arch bridges in recent years and the promise of their still greater use in the future. On account of their form they constitute one of the handsomest classes of bridges.

The first important steel bridge in the world was completed in 1874. It is the arch bridge which in three spans crosses the Mississippi River at St. Louis. Its arches are without hinges and their ends are firmly fixed to the piers. This is one of the most famous bridges in existence. For a long time after its construction no metallic arches were erected in this country, although many were built in Europe. In 1888, however, the highway bridge across the Mississippi River at Minneapolis was erected, consisting of two spans of 456 feet each and which still remains the longest span of any three-hinged arch. The following year the Washington bridge over the Harlem River in New York city was completed. It consists of two spans of 510 feet in the clear and has the largest two-hinged arch ribs with solid web plates.

These were followed by a number of arches of various types, the most noted of which are the two-arch bridges over the Niagara River. The first one is a spandrel-braced, two-hinged arch with a span of 550 feet and replaced the Roebling suspension bridge in 1897. It accommodates the two tracks of the Grand Trunk Railroad on the upper deck and a highway on the lower deck. The other bridge has arched trusses with parallel chords and two hinges. It replaced the Niagara and Clifton highway suspension bridge in 1898, and as its span is 840 feet, it is the largest arch of any type in the world. The manner in which this arch was erected furnishes an illustration of the effort which is made by engineers to conform the actual conditions so far as possible to the theoretic ones involved in the computation of the stresses. Since the stresses in an arch having less than three hinges are statically indeterminate, stresses of considerable magnitude may be introduced into the trusses if the workmanship be imperfect, the supports not located with sufficient precision, and the arch closed without the proper means and care.

The Niagara and Clifton arch was first closed as a three-hinged arch and then transformed into a two-hinged arch by inserting the final member under the sum of the computed stress due to the weight of the truss, and that due to the difference between the temperature at which the closure was made and that assumed as standard in the stress computations. This stress was secured in the member by inserting it when the hydraulic jack which forced apart the adjacent ends of the shortened chords registered the required amount of pressure. The arch had been erected as a pair of cantilevers from each side extending 420 feet out beyond the supports, and when the closure was made the two arms came together within a quarter of an inch of the computed value. Such a result involving the "accuracy of the calculation and design of the entire steel work, the exactness with which the bearing shoes or skewbacks were placed, and the perfection of the shopwork" has been truly characterized as "phenomenal." In order to reduce secondary stresses to a minimum the members were bolted up during the cantilever erection and the bolts replaced by rivets after the closure of the arch rib.

The past decade witnessed the introduction and extensive development of arches of concrete and of concrete-steel construction. In the latter kind a small amount of steel is embedded in the concrete in order to resist any tensile stresses that may be developed. During this period more than 150 concrete steel bridges have been built in this country. In the same year in which the largest metallic arch was completed, the five concrete-steel arches of the bridge at Topeka, Kas., were finished. The largest one has a span of 125 feet and still remains the largest span of this type in America, although it has been exceeded in Europe. Considerably larger spans are to be built this season, while others are included in the accepted design for the proposed Memorial bridge at Washington.

It is the smaller steel structures which are destined more and more to be replaced by arches of this material. The steel bridges require repainting at frequent intervals, constant inspection, occasional repairs and finally replacing by a new structure after a relatively short life, on account of rust and wear, unless it is required even sooner on account of a considerable increase in the live load. The concrete arch requires practically no attention except at very long intervals.

The safety of operating the traffic makes it desirable to have as few breaks as possible in the regular track construction of a railroad, and this constitutes an additional reason why concrete or stone arches are being substituted for the smaller openings. The decreasing cost of concrete tends to an extension of this practice to openings of increasing size. Last year, however, a bridge was completed which marks a decided departure from previous practice. The Pennsylvania Railroad built a stone bridge, consisting of 48 segmental arches of 70 feet span, at the crossing of the Susquehanna River at Rockville, Pa. It is 52 feet wide, accommodates four tracks and cost a million dollars. This bridge has not only the advantage of almost entirely eliminating the cost of maintenance, but it also has sufficient mass to withstand the floods which occasionally wreck the other bridges on that river. This year the same railroad is building a similar bridge over the Raritan River at New Brunswick, N. J.

Of movable bridges the largest swing span existing was erected in 1893 at Omaha over the Missouri River. Two years later a four-track railroad swing bridge was built by the New York Central Railroad over the Harlem River in New York city, which is only 389 feet long between centers of end pins, but which weighs about 2500 tons, and is accordingly the heaviest drawbridge of any class in the world.

During the past decade a remarkable development was made in drawbridge construction by the modification and improvement of some of the older types of lift bridges and the design of several new types. At South Halstead Street a direct-lift bridge was built in 1893 over the Chicago River, in which a simple span 130 feet long and 50 feet wide is lifted vertically 142½ feet by means of cables to which counterweights are attached. Formerly, only very small bridges of this kind were used, as those, for instance, over the Erie Canal.

In 1895 a rolling lift bridge over the Chicago River was completed. In this new design as each leaf of the bridge rotates to a vertical position it rolls backward at one end. When closed the two leaves are locked at the center, but they are supported as cantilevers. This form has been found to have so many advantages for the crossings of relatively narrow streams, where an unobstructed waterway is required and the adjacent shores are needed for dock room, that a score of important structures of this class have been built in different cities. The largest span that has been designed is 275 feet between centers of supports, while the widest one is to accommodate eight railroad tracks crossing the Chicago Main Drainage Canal.

About the same time and under similar conditions another type of bascule bridge was built at Sixteenth Street, Milwaukee, in which, as each leaf moves toward the shore, one end rises and the other falls, so that its center of gravity moves horizontally, thus requiring a very small expenditure of power to operate the bridge.

Several improved forms of hinged-lift bridges have also been designed and built in Chicago and elsewhere. In a small bridge erected in 1896 on the Erie Railroad in the Hackensack meadows there is only a single leaf hinged at one end and lifted by a cable attached to the other end. The counter weight rolls on a curved track so designed as to make the counter balance equally effective in all stages of opening and closing the bridge.

A novel bridge is now being built over the ship canal at Duluth which is different from any other type in this country. The general scheme is similar to that of a design made by a French engineer who built three of the structures in different countries. It consists of a simple truss bridge 393 feet 9 inches long, supported on towers at a clear height of 135 feet above high water. Instead of supporting the usual floor of a highway bridge it supports the track of a suspended car which is properly stiffened against wind pressure and lateral vibration, the floor of the car being on a level with the docks. This ferry is operated by electricity. The loaded car, its hangers, trucks and machinery weigh 120 tons. In the French design a suspension bridge was used instead of the simple truss bridge.

A bridge is being built across the Charles River between Boston and Cambridge that deserves especial mention and marks a decided advance in the growing recognition on the part of municipal authorities of the importance of esthetic considerations in the design of public works. It consists of 11 spans of steel arches whose lengths range from 101½ to 188½ feet. Its width is 105 feet between railings. It is claimed that this bridge "will be not only one of the finest structures of its kind in this country, but will be a rival of any in the old world." Its length between abutments is 1767½ feet, and it is estimated to cost about two and a half millions of dollars.

The problems incident to the replacing and strengthening of old bridges frequently tax the resources of the engineer and demonstrate his ability to overcome difficulties. Only a few examples will be cited to indicate the character of this work. In 1900 the Niagara cantilever bridge had its capacity increased about 75 per cent by the insertion of a middle truss without interfering with traffic. In 1891 the entire floor of the Cincinnati and Covington suspension bridge was raised four feet while the traffic was using it. It may be of interest to state that the two new cables, 10½ inches in diameter, which were added to increase the capacity of the bridge, have just about three times the strength of the two old ones, 12½ inches in diameter, and which were made a little over thirty years before. In the same year the old tubular bridge across the St. Lawrence River was replaced by simple truss spans without the use of false works under the bridge and without interfering with traffic. On May 25 of this year the Pennsylvania Railroad bridge over the Raritan River and canal at New Brunswick, N. J., was moved sidewise a distance of 14½ feet. Five simple spans 150 long and a drawbridge of the same length, weighing in all 2057 tons, were moved to the new position and aligned in 2 minutes and 50 seconds. The actual time that the two tracks were out of service were respectively 15 and 28 minutes. On October 17, 1897, on the same railroad near Girard Avenue, Philadelphia, an old span was moved away and a new one, 235 feet 7 inches long, put in exactly the same place in 2 minutes and 28 seconds. No train was delayed in either case.

#### BELL FOUNDRY.

LIKE most other arts and crafts, bell founding was for some centuries almost exclusively confined to the monks. St. Dunstan was a skillful workman, and was said by Ingulphus to have given bells to the western churches. Later on, when a regular trade had been established, some bell founders wandered from place to place; but the majority settled in large towns, principally London, Gloucester, Salisbury, Norwich, Bury St. Edmunds, and Colchester. It was long a fixed idea that silver mixed with the bell metal improved the tone; but this is now considered incorrect. The "Acton Nightingale" and "Silver Bell"—two singularly sweet bells at St. John's College, Cambridge—are said to have a mixture of silver; but, if true, this is not believed by competent authorities to be the cause of their beautiful tone. This idea led to the story of the monk Tandio concealing the silver given him by Charlemagne and casting the bell in the monastery of St. Paul of inferior metal, whereupon he was struck by the clapper and killed. In the ninth century bells were made in France of iron;

they have been cast in steel, and the tone has been found nearly equal in fineness to that of bell metal, but, having less vibration, was deficient in length; and thick glass bells have been made which give a beautiful sound, but are too brittle to long withstand the strokes of the clapper.

A REMARKABLE PSYCHIC CONTRAST FROM THE LIFE-HISTORY OF ANTS.

By HERMAN J. MUCKERMANN.

By a one-sided consideration of the bright aspect of ant-life certain writers of our day (Wheeler calls them "popularizers") are led to extol the psychic faculties of ants beyond measure, and even to ascribe to them an intelligence superior to that of man. In the following lines the writer purposes to present in accordance with the latest researches a very remarkable psychic contrast found in the life-history of ants, thereby to show the futility of attributing a reasoning faculty to ants merely because of certain phenomena which apparently betoken a high degree of intelligence.

It is a warm sunny day in June. In a colony of the *Polyergus rufescens* (Fig. 5) feverish activity is displayed. The Amazons (this is their popular name in

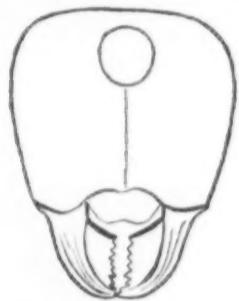


Fig. 1.—Head and Mandibles of a Formica seen from Below. (Original.) (Formica sanguinea subsp. rubicunda Em.)

Europe) having spent well nigh the whole morning in preening their legs and feelers, rally upon their battlements, i. e., on the top of their nest, and with great haste and evident excitement descend for a warlike expedition. Within about 50 paces of their castle there is in a meadow a settlement of the *Formica rufibarbis*. Already some time before some roving members of the Polyergus household have accidentally hit upon this fornicary, and now under their guidance a goodly array of about 1000 "slave-hunters" may be seen marching in an almost straight line upon their destined prey. Having arrived within 10 cm. of the enemy's stronghold, the vanguard comes to a stop, giving a violent signal with their feelers to the ranks immediately behind them. With incredible rapidity a number of emissaries hurry through the main body of the army, and in less than 30 seconds the forces are ready for the attack. In a twinkling they scale the walls of the rufibarbis bulwark. With indescribable celerity the Amazons fall upon their enemy. And there we may behold a twofold spectacle. While one part of the Polyergus warriors is murdering the defenders of the hostile nest, the other and greater part is rushing through every opening into the interior of the enemy's citadel. Some minutes have passed. A double stream of ants is issuing from the interior of

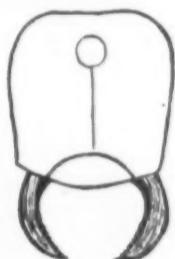


Fig. 2.—Head and Mandibles of a Polyergus seen from Below. (Original.) (Polyergus bicolor Wasm.)

the nest. Both are loaded down with cocoons, the "papooes" of ants, one consisting of *F. rufibarbis* endeavoring to save what may be saved, the other of the Polyergus troops hastily returning with their booty. There is no useless shedding of blood. The crania of the *F. rufibarbis* are trepanned only in so far as they refuse to yield up their progeny. Suddenly the scene is changed. The *F. rufibarbis*, noticing the hasty flight of the ravishers, at once pursue them to make them give up their precious burden. There is a fierce pulling and struggling hither and thither. The *F. rufibarbis* plunge their mandibles into the legs and feelers of the Amazons and cover them with venomous ejections from their abdomens. But only some of the Amazons' rearguard are constrained by superior numbers to deliver up the ravished cocoons, while one or the other of their warriors remains a corpse upon the field. In about ten minutes everything is over. The scattered *F. rufibarbis* forces return to their dwelling to restore everything, if possible, to its pristine state. The stolen cocoons, however, are handed over by the Polyergus to their slaves, already present in the nest, for further care and development, respectively, for consumption. They themselves again squat on their four hindlegs, to renew their comical cleaning operations, which they interrupt only to extort food from some passing slave. The young ants which are fortunate enough to come safely out of their cocoons, are in reality not treated by the colony as slaves (which in this case is a wrong appellation), but as full-fledged citizens. However, it is their lot, at least in the nests of the Polyergus, which are unfit for any work, to take upon themselves the construction of the nest, the

rearing of the brood, and the victualing of the whole community. And this task they undergo with masterly skill and rare devotion. Entirely forgetful, as it were, of their home and kindred, they are absorbed in caring for strangers. They are unconcerned even

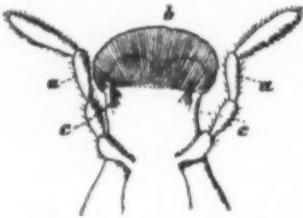


Fig. 3.—Lower Lip of a Formica (labium). (After Wasmann.) (a = labial palpi; b = ligula; c = paraglossae.)

about the propagation of their own species. That for which animals strive to the utmost they sacrifice merely in order to preserve the race of their oppressors, which would otherwise be doomed to certain destruction.

This is the exterior appearance of one of the most splendid expeditions ever observed by Huber, Forel or Wasmann, and certainly the fact narrated may betray a high degree of intelligence. For, first of all, by their warlike expeditions the Amazons seem to intend to supply their household with new auxiliaries. Moreover, the means applied for the purpose are most appropriate. "Scouts" have explored the hostile nest and seem to lead the whole army. At the right moment the signal for the attack is given. The attack itself takes place on a sudden, with great celerity and by all at once. Thus the enemy will be surprised and the number of cocoons captured will be more considerable. No blood is shed without purpose. Moreover, the Polyergus seem to distinguish very well between the useful cocoons of workers and the useless and harmful ones of the females and males. And finally the ants apparently succeed in determining their slaves to desist from the care of the preservation of their own species, and to devote all their strength, yea, even their very life, for the benefit of the colony and the progeny of their ravishers.

These few facts, indeed, seem to throw a brilliant light upon the psychic faculties of ants; and though some of them may be explained by very simple processes there are scarcely any others in the life-history

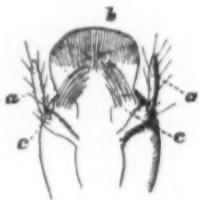


Fig. 4.—Lower Lip of a Polyergus. (After Wasmann.) (a = labial palpi; b = ligula; c = paraglossae.)

of animals which present to us a more intellectual appearance. The question now arises: Must these facts in reality be attributed to true intelligence; do they in reality involve true consciousness of finality? A short consideration of the dark side in the life-history of these very same ants will convince us that this question cannot without evident contradiction be answered in the affirmative.

As will be known to many of our readers, the Amazons, on account of the peculiar construction of their mandibles, which are not like those of other ants adapted for many functions necessary to sustain the life of the individuals and commonly exercised by those organs (Figs. 1 and 2), essentially depend on the assistance of their helpmates in many of their actions. This essential dependence goes so far that the Polyergus are throughout life even nourished by their slaves. This fact is sufficiently established by the observations of Huber, Lespèo, Forel, Adlerz, Wasmann, etc.

The writer, too, had occasion to verify the same with regard to *Polyergus bicolor*, Wasm., a newly discovered Amazon, unknown to the other scientists mentioned. The process of feeding takes place in the following manner. The hungry Polyergus first violently buffets and strokes with feelers and forelegs the head of a passing slave. If the slave has sufficient food in its little crop, it causes a drop of the prepared liquid to appear on its lower lip, where it is licked off by the Amazon. Now it is certainly a very

any exterior aid? As to the second question, Wasmann sums up the results of a minute examination of the Amazon's mouth-parts in the following statements: 1. By the construction of their mouth-parts, and especially by the shortness of their palpi, the Amazons show, indeed, that they are less adapted for independent feeding than other ants related to them (Figs. 3 and 4). 2. There is, however, no organic impossibility in the way of their independent nutrition. For other ants with organs not less imperfect feed themselves without being assisted by others. 3. The structure of the so-called paraglossae seems even to indicate that the Polyergus are able to obtain food in an extraordinary manner (Figs. 3 and 4). Yet these inferences from the construction of the mouth-parts of the Polyergus would in themselves not be sufficiently warranted, unless actual experiment had corroborated them. Examining the mandibles of the Polyergus, we find that on the interior side they have a slight excavation widening toward the head (Fig. 5). But as the Amazons are endowed with great predatory instinct, they take delight in exercising their mandibles upon their foes; and if then these organs happen to be inserted into the body of ants or their cocoons, the channels contained in them convey the liquid to the lower parts of the mouth. Now Wasmann with sufficient frequency observed the following fact: While the mandibles of a Polyergus, having pierced the body of an enemy, were resting quietly in the same position, their palpi and lower lips were moving in regular intervals toward the inside, this movement lasting from three to five minutes. But precisely this motion of the palpi and lip constitute the eating operation of ants. Moreover, Adlerz, Wasmann and the writer himself have noticed how in observation nests Polyergus accidentally coming into contact with the glass panes of the walls licked off the drops of precipitation found upon them. From this it follows that the Polyergus are actually capable of independent nutrition. What should we, therefore, naturally expect of them, if they are robbed of their slaves? Most assuredly that impelled by hunger they would make use of their power of eating and would make an independent effort to partake of the food placed before them. But what are the actual facts? The result of numberless experiments is the following. Although the Polyergus are able to eat and accidentally do eat now and then, they must absolutely be fed by their slaves. If they are to remain alive, You may prepare for them the most pleasant dwelling and the most exquisite nourishment, if you neglect to provide them with slaves, they are doomed. Their desire for nourishment impels them only to seek it from their slaves, but never to make an attempt at independent nutrition. Therefore, this ant apparently so intelligent in its warlike operations, is so abnormally stupid and helpless in private life, as not to be able to establish the simple relation between the promptings of appetite and independent nutrition, and prefers death to making use of its faculty of eating. But a being that is capable of eating and from experience knows how to eat, yet even in the greatest necessities with unexceptional regularity, prefers to die than to eat independently; such a being is a rather poor specimen of ant intelligence. For there can be no question here of some error of judgment, as it may occur in man endowed with intelligence. Real error cannot be a normal occurrence; it is never found in all individuals of the same species; it cannot be committed, unless there is at least some appearance of truth and some influence of passion or prejudice. Regarding the actions in question, however, all the circumstances point not to an accidental error, but to an entire absence of intelligence. For in the first place, these actions are entirely useless for the individuals performing them. Secondly, they occur with all the individuals so far observed both in Europe and in America and must consequently be ascribed to the nature of those ants. Finally, there can be no question of the influence of their will under the stress of some passion or predilection. For every natural desire would prompt them to do the opposite. Thus we are forced by inexorable facts to deny to the great warrior ant, the much lauded Amazon, the faculty of acting with the consciousness of final purpose and to assign her to a place in the realms of mere animal instinct.

Authors consulted:

1. Dr. Auguste Forel. Les Fourmis de la Suisse, Zuerich, 1874.

2. E. Wasmann. S. J. Vergleichende Studien ueber das Seelenleben der Ameisen und der hoheren Tiere, ed. 2. Freiburg, 1900.

3. Die zusammengesetzten Nester unter gemischten Kolonien der Ameisen. Muenster, 1891.

ECONOMIC USES FOR SHELLS.\*

It may surprise some to learn that shells rank among the principal "fishery" products of the world. This refers to those used for industrial purposes and not to the large supplies for museum and cabinet collections. In London the sales of pearl shell or mother-of-pearl amount to about \$4,000,000 each year, and the annual imports of this material into the United States usually exceed \$1,000,000 in value. The shells caught in this country aggregate about 1,000,000 tons annually. The economic utilization of these is more diversified than is generally supposed, giving employment to many thousands of persons and constantly increasing in importance.

The most valuable item in shell production is mother-of-pearl. A relatively large variety of shells are pearly or nacreous. The most important is the pearl oyster, found in many inshore tropical waters of both continents. The shells vary greatly in color and iridescence, but three general classes are recognized, viz., white or silver-lipped, yellow or golden-edged, and smoky or black-edged, the last yielding the so-called "smoked" mother-of-pearl. The white shell has the silvery lining uniform over the surface, and as it may be cut up to greater advantage it is the most valuable. When black pearl buttons are fashionable the black-edged shell sells almost as high as the best



Fig. 5.—A Polyergus (Polyergus bicolor Wasm.). (Original.)

rare case that an animal so much depends on others that it must even be fed by them during its whole existence. And thus the two interesting questions present themselves: First, what will happen to the Polyergus if deprived of their slaves? And secondly, are they at all able to obtain food independently of

white shell. A fair valuation of mother-of-pearl shells is \$100 per ton, although the choicest sell for upward of \$1,500 per ton.

During the last ten years large quantities of low-grade pearl shell have been secured from the freshwater mussels of the United States. These occur principally in the Mississippi River from Prairie du Chien, Wis., to Quincy, Ill., and to a much less extent in adjoining waters. Although their utilization originated so recently as 1891, the present annual product is very large, exceeding 20,000 tons during certain years. The value is much less than that of choice pearl shell, selling usually for less than \$25 per ton.

Many univalve shells are sufficiently nacreous and iridescent to be used as mother-of-pearl, especially abalones, top shells, "green snail," shells, etc. In variety and intensity of coloring the pearly lamina of some of these exceeds that of the pearl oyster. However, the coloring is not so harmonious nor is the shell so thick and flat as in the pearl oyster, consequently they are not desirable for many purposes for which the latter are employed.

Mother-of-pearl is used in the manufacture of a great variety of articles for which it is peculiarly adapted by reason of its hardness and beauty. Most important of these are buttons, knife handles, parasol handles, buckles, penholders, pistol stocks, etc. It is also used for inlaying and for covering opera glasses, card cases, etc. In the aggregate a very large number of persons are given employment in working up this material. Formerly the business was centered at Birmingham, England, and Vienna, Austria, 4,000 persons being thus employed at the former place a few years ago; but it has gradually extended to other localities, especially in France and the United States. It is claimed that about 8,000 persons are employed in working pearl shell in Austria, 5,000 in England, 4,000 in France, 3,500 in America, and many in various other countries. The manufacture of pearl buttons in this country from domestic shells dates from 1891 and is already of very great extent, the sixty factories giving employment to about 2,500 persons and using 12,000 tons of shells annually, yielding about 600,000,000 buttons.

Pearl shell is much used for inlaying, especially of musical instruments, jewelry boxes, domestic furniture, church vestments, etc. Artistic work of this nature is done in the United States as well as in Europe and Asia. The shell is cut in simple patterns and is also used in floral and in arabesque designs. For this purpose the brilliantly colored abalone shell is used with beautiful effect, especially when combined with white shell. Some very elaborate work of this nature is done. A mandolin recently exhibited in this country contained more than 2,000 pieces of four different kinds of shell, and 225 days' work were expended in cutting and finishing the pieces, the whole representing an investment of \$1,500. Some years ago there was exhibited in New York city a piano, the entire keyboard of which was of pearl. The body of the keys was of ordinary white shell and the flats and sharps were of green abalone, the effect being extremely rich and pleasing.

The most abundant shells in America are those of oysters and clams, especially the former. The product of these approximates 30,000,000 bushels annually and the purposes to which they are applied are numerous. The most important use is in roadmaking. At various points on the Atlantic seaboard, and particularly in the Chesapeake and the Delaware Bay regions, many miles of good roads have been made of this material. It is estimated that 3,000 miles of roads on the Atlantic coast have been surfaced with shells. Connecticut, Long Island, the Delaware Bay side of New Jersey, Delaware, Maryland, Virginia, North Carolina and Louisiana contain many excellent examples of oyster shell roads. To cover a road sixteen feet wide to a depth of fifteen inches in the middle and eight inches at the sides requires about 30,000 bushels of shells per mile, costing on an average 3 cents per bushel, or a total of \$900 per mile. To keep such a road in good repair requires about 2,500 bushels of shells per mile annually at a cost of about \$75. Although they constitute the cheapest and most convenient material in the sections where they are commonly used, shells are not wholly satisfactory for road material owing to their rapid wear and the spreading of objectionable lime dust.

Oyster shells are largely employed as ballast for beds of railroads. While not nearly so durable or steady as rock, they answer the purpose fairly well and are the most convenient and economical material in many localities. Examples of their use for this purpose occur on many of the railroads in Maryland, Virginia and Louisiana.

Oyster shells have been extensively used as a source of lime, especially for agricultural purposes, as well as in masonry. Most of the brick buildings erected in Colonial times were solidified with shell lime. Owing to its tendency to absorb moisture and thus make the houses damp its use for this purpose was abandoned soon after the discovery of limestone in abundance. The quantity of burned oyster shells spread on farming lands amounts to many thousands of tons annually. These shells are also crushed into small particles and fed to chickens to improve their digestion and their egg-laying. This use is increasing in popularity. Oyster shells are also employed in the manufacture of certain special grades of steel owing to their large content of carbon.

A somewhat recent use for shells in America is for spreading on private oyster grounds for the purpose of obtaining a "set" of young oysters. When the extremely small oysters hatch from the floating eggs and sink to the bottom it is important that they find a clean substance for attachment, otherwise they are readily smothered. It is estimated that 4,000,000 bushels of oyster shells are used annually for this purpose, mostly in the waters of New York, Connecticut and Virginia. They are spread immediately before the spawning season, usually in June in the Chesapeake region and in July in Long Island Sound.

Several other varieties of shells are used for "spat collecting," especially "jingles" (*Anomia ophippium*), "quarterdecks" (*Crepidula fornicata*) and scallops (*Pecten irradians*). These are obtained mostly from Peconic Bay, at the eastern end of Long Island, where several hundred thousand bushels of mixed shells are

dredged annually to be marketed in the oyster-planting regions of New York and Connecticut. They are considered superior to oyster shells for "clutch," owing to the fact that they are smaller and only a few young oysters "set" on each, thus avoiding the crowding which occurs when large shells are used. Another reason for their preference is that they are easily broken and disintegrated, and consequently do not encumber the ground after serving as "spat collectors."

Large quantities of shells are used for ornamental purposes. Especially prominent among these are the abalone or ear shells, obtained from California, Japan and various other countries. About 500 tons of abalone shells are gathered annually on the Pacific coast of America, worth about \$40,000. This product, however, is only one-fourth or one-third as large as it was twenty years ago. When cleaned and polished, the highly iridescent green, red and pearly white colors are exquisite and make these shells beautifully ornamental. Much skill is exercised in polishing in order to produce the best effects. Some of the abalone shells are of such shape and coloring that it is possible in grinding to produce a perfect cross of black against a pearly white background; these meet with ready sale, the purchasers usually assuming that the cross appeared on the shell in nature.

The large green conch or fountain shell, obtained on the Florida coast, the West Indies, etc., is much used for ornament. The graceful curves and the delicate tints of lovely pink color make it one of the most attractive of all shells. It is much used in making brooches, earrings, etc., and in the form of beads in imitation of pink coral and pink pearls. Large quantities of conches have been pulverized and used in porcelain manufacture.

The pectens or scallop shells have long been admired owing to their beauty of form. During the Middle Ages pilgrims ornamented their clothing with them, as an indication, doubtless, of having crossed the sea to the Holy Shrine in Palestine, and for this reason they

the limb in order to save his life. In case both hands are imprisoned, as in head diving, escape is impossible without assistance, which usually arrives too late. A beautiful pair of these shells are used as benefices in the Church of St. Sulpice in Paris. This pair is said to have been a gift of the Republic of Venice to Francis I.

The most artistic use of shells is in the formation of cameos, which are cut from univalve shells made up of laminae of different colors. The middle lamina, which is usually white, forms the body of the figure in bas-relief, and the dark inner layer forms the ground. The outer or superficial layer is entirely removed, or it may be used to give a varied appearance to the surface of the design.

Of the several varieties of shells employed in cameo cutting, the black helmet (*Cassis tuberosa*) is the most valuable. This occurs in the West Indies and to a less extent on the American coast south of Cape Hatteras. It has a blackish inner coat and the cameo cut from it shows white upon an onyx ground varying from dark claret to much lighter shades, producing effective results. This shell is ordinarily twelve inches in length, and usually five brooches of average size and several smaller articles may be cut from each one. The bull's mouth (*C. rufa*) is also popular; it has a red inner coat and a sardonyx ground. The horned helmet (*C. cornuta*) gives white upon an orange yellow background. The laminae of this shell are apt to separate, making it disagreeable to work. The queen conch is also used to a considerable extent; the ground color is brilliant pink, which is somewhat evanescent on exposure to light. An attractive method of using this shell is to incise the bas-relief in the pink layer, using the white as the background, thus reversing the usual method.

Shell-cameo figures consist of copies of antiques, original designs, and portraits. Sometimes an entire shell—especially of the black helmet variety—is used, and either a small figure is cut upon the face of the



GIANT WILD SHEEP IN THE BERLIN ZOOLOGICAL GARDENS.

were known as "pilgrim shells." To commemorate that event they were preserved in the heraldic devices of many families whose ancestors had performed that journey. Scallop shells were formerly much used by cooks for holding foods, hence the name "scalloped oysters."

The popularity of shells for personal ornamentation has resulted in their use as currency or standard of value among many primitive peoples. A well-known example of this is the wampum of the North American aborigines, made from the quahog or hard clam shell, so numerous on the Atlantic coast. Somewhat less extensive was the use of the tooth shell or Dentalium on the northwest coast, and of the abalone on the California coast. Even at the present time in many parts of Africa and to a less extent in British India species of the cowry family are used as currency. In some seasons eight or ten vessels carry cargoes of the money cowry (*Cypraea moneta*) to the west coast of Africa, where they are exchanged for palm oil and other products.

The window-glass shell (*Placuna placenta*), found in the Pacific and Indian oceans, and especially among the Philippine Islands, has an almost flat bivalve shell, six or eight inches in length. The inside of this shell is glazed over and has a subdued pearly luster. It is so thin and transparent that print can be read through it, and it is used as a substitute for glass in windows, admitting a soft, mellow light into the room. It is commonly used in the Philippines in windows of residences, etc.

The giant clam (*Tridacna*) yields the largest and heaviest shells in existence, single pairs weighing over 500 pounds in some instances. These are much used for ornaments, especially for fountain basins and for benefices or holy-water fonts. They are found in many tropical waters, and especially on the pearl grounds. Divers inadvertently placing a hand or a foot in the open shell are held imprisoned, and it is necessary for the unfortunate man to at once cut off

shell or the entire surface is covered. In the latter case the principal design is in the center and around it are such minor designs as the fancy of the artist dictates. Some of these sell very high, and hundreds and even thousands of dollars are secured for a single carved shell. One exhibited recently in this country by a Naples artist represented two years' work.

The real value of a cameo consists in purity of material, beauty of design and delicacy of workmanship. As an art, shell cameo cutting has become much degraded, having fallen under the deteriorating influences of low-priced productions. Most of the cutters at present are merely skilled workmen and not artists, and the bulk of the output consists of cheap productions, quite inferior to those of half a century ago. For this reason the fashion for them has greatly declined. However, there are yet several shell cameo workers who compete with sculptors in artistic productions.

CHARLES H. STEVENSON.

#### THE GIANT WILD SHEEP IN THE ZOOLOGICAL GARDEN AT BERLIN.

AFTER most of the zoological gardens were established, Africa came to the front in the commerce of living wild animals, as well as a field for procuring valuable models of the large species. The trapping and catching of animals in the northeast and south of the continent became so well organized that Asia was pushed somewhat in the background; more so than it deserved, for its zoological treasures are fully as remarkable as those of Africa. The interior of Asia furnished scarcely any, and yet these mountain chains and plateaux are the home of particularly interesting hooved mammals, from which some of our most important domestic animals are either descended or to which they are closely related. It is the more agreeable to notice that lately a change has taken place in the importation of animals.

This to a great extent is owing to the indefatigable

enterprise of Karl Hagenbeck, the well-known dealer in large animals, who, when the East African Soudan began to fail as a source of supply and finally was closed against him by the uprising of the Mahdi, cast about for another field of exploration. In this he was seconded by the Duke of Bedford, one of the richest landed proprietors of England, who, on his estate of Woburn Abbey, indulges his fondness for animals and carries on the naturalization of strange species on the largest scale. Thus it came about that recently we have seen in our market beautiful animals from the interior of Asia, especially from the extensive and branching chain which goes by the name of the Altai Mountains.

From this region, from the Russian and Chinese border, comes the splendid specimen whose portrait illustrates this article. It is the Argali ram, the first of the kind to visit Europe alive. When I first saw him and his gigantic horns at Stellingen, the new Hagenbeck park, laid out for the purpose of this business, I was thrilled with one of those pleasurable moments which an animal lover, engaged in the work of the zoological gardens, can never forget. The splendid fellow has greatly improved since his picture was taken. In this we see him, as it were, still in traveling costume, a little thin and worn by fatigue. At present he has a different appearance. His body has become as stout as that of a small bullock, and his fine colors are developed; the body reddish gray, the head, neck and legs white and gray; while the horns, pushing from the skull, are continually growing, so that I have been obliged to have the door of his rocky stall enlarged. The whole impression is grandly beautiful, and must cause delight to every hunter and friend of nature.

Of the gigantic wild sheep, which are found in the high mountains of Central Asia and have spread from Kamtschatka to North America, where they are called big-horn sheep, there are many varieties. Our Argali ram belongs to the species which inhabit the Sair Mountains in the great Altai chain, and was formerly included among the real argali (*Ovis ammon*, L.). These have been recently named *Ovis sairensis* by Lydekker.—For our illustration and the accompanying description, we are indebted to *Illustrirte Zeitung*.

#### INDIA INK—HOW IT IS MADE.\*

THE invention of India ink (or, more properly, Chinese ink) is ascribed, by several Chinese historians, to Tien-Tschun, who lived in the time of the Emperor Hoang-ti, about 2697 B. C., or about 4600 years ago. It is in all respects an excellent substance, one which, compared with all other water-colors, displays all the good qualities that one can ask for, among which I may mention depth of tone, fineness of subdivision, covering power, resistance to alteration by light and by water, and the length of time which its particles remain in suspension when once rubbed up.

On account of these excellent qualities it enjoys among artists an universal popularity. The extraordinary advantages it possesses over all other water colors, makes it indispensable in many branches of art, yet queerly enough, nobody seems to take enough interest in it to inquire how or where it is made, and to this very day the sources of information in this direction are very meager. We only know in a general way that the Chinese manufacture it of a lampblack, but as to the methods, etc., employed, we have been in total ignorance until very recently, and up to the present time, no European has succeeded in making it, as good at least, as the Chinese article.

Under these circumstances no apology is needed for presenting the accompanying article on the preparation of the ink.

As everyone knows, China is rich in a very ancient and very comprehensive technological literature, with which we are gradually becoming acquainted through the works of various orientalists. The following we borrow from the work of Maurice Jametel (Leroux, Paris, 1882), which treats of the manufacture of the ink, as taken from Chinese documents.

Jametel states in his report that India ink in sticks was introduced in the third century before Christ, and that the best ink comes from the province of Kiang-si. The manufacture of the article was first regulated by an imperial order in the seventh century A. D., which designated several persons to whose supervision the manufacture was entrusted. Li-Ting-Konei, who lived in the tenth century A. D., made the best varieties of ink—inks that have remained, down to the present day, unrivaled by the product of any other manufacturer whatever. Li-Ting-Konei produced different varieties of ink, of which those moulded in the form of a sword were the best.

Tschang-yu (the manufacturer of the so-called "Dragon" inks), and a number of other manufacturers of the product, all of whom developed special processes in making it, sought to immortalize themselves as rivals of Li-Ting, but were all and all alike unsuccessful in achieving permanent fame, and were forgotten shortly after death.

The greatest variety of substances have been used in the production of the carbon, or "lampblack," from wood of the fir, rhinoceros horn, and from mineral oil to pomegranate root bark, in the effort to get the softest carbon, which is the main essential to success. The best and finest ink must, too, have that clinging, characteristic odor of musk (made up in the common sorts by the addition of musk).

Besides this soot or black, there is another pigment used in China in the manufacture of the ink, a black derived from a fish called "vou-tseya," known, very naturally so, as the ink fish. Its coloring matter is not a pure black, but rather a sepia brown, and hence its presence is easily recognized by the lightness of the color of the ink.

In this connection we would mention a certain manufacturer of India ink who lived in the fourteenth century of our era, and whose name was Chen-Ki-Son-en. Unlike the rest of the trade, who kept their

processes secret, Chen-Ki made his known to the public, and from his works, as far as lies in my power, I draw a more detailed description of the manufacture of the substance.

As fuel for the production of the black, Chen-Ki-Son-en used a very fat oil, derived from *Dryandra cordata*, and, along with it, hemp seed. The oil was submitted to a preliminary process which consisted in warming it up in contact with rasped redwood (Guilin wood), sandal-wood, almonds, grains of gardenia and oppopanax, and then drawn off into bottles and stored for a long time. In the preparation of the black, the manufacturer used small earthenware bowls, which he filled with the oil, and furnished with a wick made of rush. Thus prepared, the little lamps were stood in clusters of from 8 to 20, on a tile placed in the bottom of a shallow vessel, filled with water. Above each lamp hung an inverted funnel of earthenware, glazed on the inside, which served as the collector of the soot. This same description of lamp, arranged in the same manner, is used to-day, the object of the water being to prevent the oil from becoming too hot—cold oil, as is well known, producing the better lampblack. This is shown in the lampblack factories, where the product of oil burned in winter is far superior to that made in summer.

The production of the soot is carried on in rooms completely closed, even the openings being pasted over with paper to shut off every possible air draught. At intervals of about an hour, the lamps are cleaned, and the funnels renewed. When sufficient soot has collected on a funnel, it is removed by means of a feather fan. It is then sifted and put in paper boxes for preservation.

The first step in the production of the ink consists in mixing the soot with glue. The latter consists of gelatin from skins (glue) and isinglass, in the proportion of 1 part of the former to 9 parts of the latter. Of this mixture, 1 part is used to every 2 parts (by weight) of the soot. The glue used in this mixture must be cleared or purified most carefully. Then there is added a tincture prepared out of a wide range of ingredients. Most manufacturers use, in making it, a decoction of *Aconite*, *Anchusa tinctoria* and *Butea frondosa*. A little camphor is added to the tincture, and in some kinds of inks, a little musk. The main value of the tincture, from all appearances, consists in the tannic acid existing in the plants, which hardens the glue. The mixture of soot, glue and the other ingredients is pressed through a wire sieve, and then kneaded into little balls. These, wrapped in cloth, are put into a tightly-closed porcelain pot, and warmed up in a water bath. From this they pass into a mortar, where they are pounded with powerful blows for hours and hours.

During the pounding process the temperature of the mortar and its contents must be closely watched. It is necessary that an even lukewarm temperature be maintained throughout, and to keep this up, the mortar must be frequently placed in the water bath. The longer and more thoroughly the mass is pestled, the better the result. When the material is reduced to homogeneous, impalpable powder, it is subdivided into portions, and made into sticks. Each stick is then beaten with a hammer until it is perfectly smooth; the sticks, one by one, are molded into a certain form, and then put away to dry. The molds consisting of very hard wood, are box-shaped, and bear engraved figures, ornaments, etc., and are provided with a cover or lid. When the stick is forced into the mold the lid is put on and driven down with a heavy weight so as to force the still plastic material to penetrate every portion and line of the engraving. In this condition it is put away to dry.

The drying process is an important stage in the manufacture, and attention to detail is as necessary as in the mixing, or, indeed, any other of the stages. Each stick is wrapped in a very thin, soft paper, and laid in layers in a box. They are so arranged as not to touch each other, and when a row of them has been put in, the space between them is filled with fresh, but well dried, rice straw ashes. The ash must be changed and renewed many times a day, each time the half being taken away and fresh ash added. When, at length, the material is thoroughly dry, each stick is freed from dust, etc., and rubbed with a stiff brush until the surface shines with a half-polish. It is now slightly rubbed with a cloth slightly moistened, and a final polish is put on with an agate burnisher.

The process of drying, as detailed, is a very rational, as well as practical method, as the ink is dried very rapidly, without the use of heat, which latter would soon destroy the substance by superinducing the production of ferments or molds and decomposition of the organic matter in its composition.

Since making the above translation, we came across a paragraph in another journal—the *Chemische Zeitung*—a statement from Mayert that when finely powdered coal, either charcoal or stone-coal, is treated with concentrated sulphuric acid in the presence of oxygen (in the shape of some substance like mercury sulphate), carbon dioxide and sulphur dioxide are evolved, under the action of which the particles of carbon are still further subdivided. The process of subdivision progresses as long as heat is applied, until a product is finally attained so comminuted that it remains indefinitely suspended in water, and will serve for the production of the finest India ink.

F. L. J.

#### RECOVERED RUBBER.

A most important industrial fact is to be found in the establishment in New York of a recovered-rubber factory, financed by American capital, and to be conducted on American principles. The subject being one on which but little, and that of a superficial character, has appeared in the technical press, it is desirable to elaborate our former reference. It may be assumed that only a small portion of our readers are quite conversant with the inner meaning of such expressions as "recovered rubber," "rubber shoddy," "Pongo rubber," and so on. It may therefore be said, by way of initial explanation, that the names just given, and one or two others which it

hardly seems necessary to enumerate, one and all refer to products prepared either by chemical or physical treatment from the old rubber goods, and, it may be added, almost entirely from old vulcanized rubber. The great problem of the rubber trade is the devulcanization of the old or scrap rubber, so as to render it again capable of affording a solution in naphtha. This problem has existed since the inception of the vulcanized rubber industry. Partial success has been obtained; but it cannot be seriously contended, we imagine, by the manufacturers of the various brands of recovered rubber, that anything like the desired finality has been attained with respect to the "recovery" of vulcanized waste, using the term as synonymous with devulcanization.

The principal raw material of the American manufacture is the discarded golosh—an article which is manufactured and utilized to a much greater extent in the States than is the case in this country. What would with us be considered fabulous quantities of these goloshes are turned out weekly, and the collection of the worn ones is carried on as a regular industry, with its accompanying market quotations. Of course, there is a large leakage, so to speak, as it is not to be expected that every pair can come under the eye of the collector, systematically though he may work; all the same, the number of shoes recovered is much larger in America than in other countries where their use is at all general; and compared with other old rubber stock which ultimately finds its way back to the factory, the golosh certainly heads the list. The recovered-rubber industry having of late extended from America practically over all Europe, the collection of old stock has become an industry of considerable dimensions in Europe. Russia and Germany have followed the American lead both in collecting the various qualities and kinds of waste rubber systematically, and in working them up for new applications. It does not seem at all clear how the various firms which have lately entered the business are to obtain the necessary amount of material to keep them in full work; and if no tightness in this direction has as yet been experienced, we cannot help foreshadowing it.

To speak now of the actual manufacture, the methods adopted may be conveniently classified as mechanical and chemical. In the former case the old rubber is ground on rollers to a fine powder, which, after being run over magnets to extract bits of iron, is subjected to a current of air, whereby textile fibers are removed. The rubber is then heated in stoves up to a high temperature, with or without the addition of petroleum oil, by which treatment it becomes to a certain extent devulcanized, and capable of being rolled into homogeneous sheets. In the chemical processes the fiber is destroyed by means of acid, though loss of material results owing to the solubility in the acid bath of many of the chemicals used in compounding rubber. More especially is this process adopted in the case of old rubber garments and workshop cuttings, where the proportion of textile material to rubber is much higher than in the case of many other goods. It is said that the number of patents taken out in connection with the employment of acids and alkalies in the recovery of rubber amounts to over fifty, very many of which came up for review in a long protracted law-suit which took place a few years ago in America. At the present day sulphuric and hydrochloric acid baths alone come into practical consideration in connection with the recovery of rubber, and the use of these is free from patent rights.

The process of devulcanization is not by any means confined to firms who make it their regular business, but it is largely carried out by our water-proofers at their own works. The plant required is neither large nor expensive; indeed, it is difficult to think of another chemical process of equal simplicity, or requiring less expert attention in order to obtain the required result; that is, we mean the ordinary result. Of course, as we have already hinted, there is ample room for scientific research in the direction of making a product worth considerably more than the few pence per pound which is all the recovered material is worth when it enters afresh into the composition of rubber goods. A difficulty about the process, especially in some localities, is the disposal of the waste acid liquors. Sufficiently diluted, they may pass unheeded into sewers or open waterways, or recourse may be had to neutralization with lime, though this latter expedient by no means does away with the whole difficulty.

In addition to the dirty acid liquor from the treatment tanks a considerable amount of dirty water results from the subsequent washing of the rags on iron rollers, whereby the rotted textile is removed, this thorough washing being necessitated not only on account of the admixed fiber, but also to insure the freedom of the product from any traces of acid. That this acid-recovery process is carried on profitably may be considered proved by the regular demand there is for the rags by dealers. These rags, both cotton and woolen, are lumped together, and fetch from 14s. to 18s. per hundredweight. As by the ordinary method of treatment the texture is destroyed, there is no attempt made to sort out and sell separately the more valuable woolen rags from among the cottons and unions with which they are usually lumped. Of course, if the proposal which has been made in certain quarters to remove the rubber without destroying the cloth were carried into effect, it would become almost a matter of necessity to make this differentiation, because the market price of the recovered woolen rags would differ so widely from that of cotton. We understand that processes for recovering both the rubber and the textile fabric have been carried on in an experimental stage in years gone by, the attempt arising from the undoubted profit which must ensue if the matter can be successfully accomplished. It appears, however, that the working expenses and one or two other important details contributed to make the expected success into a failure; and although subsequent efforts have been put forward on improved lines to effect the same end, we are not in a position to testify to any positive advancement. It is probable that a difficulty would be experienced in obtaining a sufficient quantity of pure woolen rags if it was sought to carry out the recovery process on a large

\* From the German of Christian Mangold in the *Farben Zeitung*. Translated for the National Druggist.

scale, because, for one reason or another into which we cannot stop to inquire, the heavy woolen mackintosh has suffered a relapse in popular favor. Great progress has been made in late years in the utilization of what is known as "old insertion"—that is, hose-pipes, and so on, which contain a large proportion of canvas intimately blended with the rubber. The resulting product is not of a high quality; indeed, this could hardly be, seeing the usually decayed state of the old rubber, but still it finds a market at a price which returns a profit to those who exploit it, and the fact is one that seems to deserve notice at our hands as indicating an advance. Of unvulcanized scrap rubber there is but a comparatively small quantity to be obtained, though of course reclaimed rubber of this description is of much higher value in the eye of the rubber manufacturer than is the ordinary vulcanized product. The source from which the bulk of this is obtained is old card-clothing—that is, the rubber-faced textile material used in cotton-spinning mills. In some cases certainly the rubber is vulcanized, but this is by no means universal, and an English rubber-recovery firm draw the bulk of their rubber for one of their special products from the card-clothing source. It may be taken that the fact of old rubber having a value of a sort is now generally recognized, as large users of rubber, such as our government departments and the railway companies, are now accustomed to dispose of their old material by tender or auction.

To the tyro in these matters the purchase of such material cannot be recommended as likely to prove a profitable investment, because the pitfalls into which the non-expert in such dealings may fall are both numerous and varied. Of course, the skillful buyer is safe; but the competition of late years must have had its inevitable result in diminishing profits, and though definite expressions of opinion are not readily obtainable from old-established firms in this country on the point, it is clear that some degree of apprehension is felt as to the effect of the recent American invasion. There is, however, a tendency among rubber manufacturers to use this recovered rubber to an increased extent, in place of the oxidized oil products which have now, for so long, been utilized as a cheapening material. Those whose opinion may be expected to carry weight are in favor of this move—that is, in the case of cheap goods. For really good qualities we fancy that no one outside the ranks of shareholders in recovered-rubber factories would pretend that old material can successfully take the place of new, sound rubber, where the attributes of tensile strength and durability are of supreme importance. Still there exists, and in all probability will continue to exist, a large demand for rubber goods of low price, and in order to meet this call upon their resources the rubber manufacturers will, to judge by portents, have increasing recourse to the use of recovered material. The expectations then of those who have recently gone into the manufacture may be fully realized after all, as far as profits are concerned, despite the increased competition compared with former periods. The material which we are discussing is, as will be gathered from what has gone before, by no means of one quality or composition, and even that which is sold under some definite name or mark may vary considerably in its constituents from time to time. This involves the buyer in some difficulty, as it is not customary to buy and sell on analysis. As an example of the heterogeneous nature of reclaimed rubber, the following analysis, by Henrques, of a New York product may be given:

Specific gravity .....	1.66
Oxide of lead .....	12.87 per cent
Sulphate of lime .....	22.13 "
Carbonate of lime .....	18.00 "
Oxide of iron .....	.80 "
Silica .....	1.75 "
Water .....	.52 "
Free sulphur .....	.71 "

The remainder, with the exception of some asphalt and lampblack, was presumably rubber. This analysis is merely given as a specimen, and must not be taken as being necessarily an average of what is a regular article of export to England from America.—Engineering.

#### EXALBUMINOUS FRUIT OF MELOCANNA.

DR. O. STAFF has read a paper before the Linnean Society on the fruit of *Melocanna bambusoides*, Trin., an endospermless viviparous genus of Gramineae, found in Bengal. The fruits of this singular grass are of the shape and size of small apples or inverted pears, usually terminating with a short or long beak, the longer measuring as much as five inches in length. They consist of a hard, thick, fleshy pericarp, which contains a great deal of starch stored in parenchymatic tissue, of a testa developed as a nutrient layer and present in the mature fruit in an "obliterated" condition, and an embryo possessing an enormous ellipsoid scutellum which fills the large central cavity of the pericarp, or is partly empty. The epidermis of the scutellum is developed as haustorial epithelium of the kind characteristic of grass-seeds, so far as it is in contact with the pericarp or, rather, the nutrient layer. It is traversed by numerous vascular strands which start from a plate of tangled strands in the axis of the embryo, and send out innumerable branchlets near the surface of the scutellum. The fundamental tissue in which the strands are embedded is delicately-walled parenchyma, full of starch. There is no endosperm. Germination starts while the fruits are still on the plant, and the young shoots may attain a length of as much as six inches, while a bundle of roots is formed simultaneously. During germination the scutellum acts on the pericarp as it acts in typical grasses on the endosperm, depleting not only the store of starch and other nutrient matter deposited in the cells of the parenchyma, but finally inducing also the partial solution of the cell-walls. This structure of the fruit *Melocanna* is almost unique in grasses, and was not known before. It is probably repeated, although with some modifications, in the genera *Melocatamus* and *Ochlandra*, which the author intends to make the subject of another paper.

#### TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

**Photographic Supplies in Foreign Countries.**—It is the general impression that the United States leads the world in advertising. This may be true of many lines, but we are certainly behind in the advertising of photographic supplies. Some two years ago, I organized an amateur photographic club which counts five nationalities among its members. This has brought me in close touch with many interested in the art, and I am pleased to find that American photographic appliances have an exceptionally good reputation among foreigners. American manufacturers have reached a more satisfactory solution of the problem of a practical combined hand-and-stand camera than their foreign competitors, and two lines of American sensitized paper are recognized as very superior by advanced workers throughout the world. Our plates and films have a universal reputation for excellence, but owing to the very high prices asked for plates, the latter cannot compete abroad with those of foreign manufacture. A good reliable English plate can be bought for half the money asked for the American article. With this exception, we can hold our own in price. In quality we are not excelled, and in several lines not equaled. We have the material, but lack the enterprise to push our goods abroad. Among the thousands upon thousands of amateurs throughout the world, the demand is very large, and it is astonishing to find our makers behind the English, German and French in catering to this demand.

Setting aside for the moment the subject of foreign advertising, we are without a single photographic publication in America carrying sufficient advertising to make the publication of special interest to foreign dealers on the lookout for photographic supplies. Other lines of American industry have trade journals that are widely patronized by the manufacturers, but the home photographic trade goes almost unrepresented. England possesses, in the British Journal of Photography Almanac, an annual publication which dealers and enthusiastic amateurs are glad to get. The number for this year (1902) is a bulky volume of 1550 pages. Of these, 1010 full pages are devoted to the advertisements of 245 advertisers. As many of the advertisers are general agents representing several manufacturers, there are probably four or five hundred different makers represented. I believe this publication to be one of the most valuable advertising mediums in the world. With the Journal Almanac in his hand, a foreign dealer is in close touch with the English supply trade. He finds there every novelty in his line, and as the leading manufacturers occupy enough space to cover briefly their whole field (several firms utilize upward of thirty pages each, and one well-known house fills sixty-five pages), the dealer has before him abridged catalogues of practically every maker in Great Britain.

Now let us see what the United States has to offer in this line. We have several very good photographic annuals, so far as the quality of the reading matter is concerned. Two of these are before me, and I find that in illustrations and general make-up they are in advance of the British annual referred to above. They have a comparatively large foreign circulation, and are much appreciated for the good things they contain, but they lack the most valuable feature of all—representative advertising. The 1900 issue of the American Annual of Photography, which is the largest of our annuals, contains 489 pages. Of these, 119 pages are devoted to advertisements, and the 70 advertisers represented seem, as a rule, content with a mere uninteresting address card. The publishers, who control a large photographic supply house, occupy most of the space. Foreign dealers obtain something even from this poor advertising array, but very little as compared with the British Almanac. The fault is not with the publishers. They offer a brighter setting for advertisements than their foreign contemporaries, and the advertising rates are no higher. It is our manufacturers who are at fault. If it were only possible to convince them of this and induce them to join in building up an American advertising medium like the British Almanac, our foreign trade in photographic supplies would increase greatly. I may appear to be over-confident on this point, but I have given the subject much study for the past six years and feel sure of my position. I have seen considerable orders for miscellaneous photographic supplies go to English manufacturers merely from the fact that the Almanac placed before the dealer a complete review of the latest novelties in the entire photographic line. Nothing could be learned about American goods without waiting for three months for catalogues, only then to find, perhaps, that the wrong manufacturers had been applied to, and that certain desired goods could only be obtained from other makers.

Our manufacturers could not do better than to look the field over carefully, select one or more of our photographic magazines and their annuals, and give such publications their hearty support. Let them advertise with illustrations and descriptive matter their most popular lines. The foreign dealer and amateur will, without great delay, find out the journals containing the most advertising, and these publications will soon be in possession of a circulation sufficiently large to make the trifling sum which the manufacturer has expended a splendid investment. Photographic societies are in existence now throughout the world, and they subscribe to the leading photographic papers, American, English and German. Amateurs vie with one another in obtaining the best apparatus and latest photographic novelties, thus the advertising pages are of exceptional interest. Manufacturers should, therefore, value photographic journals for the quality of their circulation rather than the mere number of copies each may issue.

In foreign advertising, American manufacturers apparently take but little interest. I find in the Tokyo Shashin Gepo (Photographic Journal) 4 German, 2 English and 2 French advertisers represented, and in the Shashin Shimpō (Photographic News) 9 English, 5 German, 2 French and 1 American. The charge for space in either of these journals is about \$4 half page and \$7 a full page for English text. An equal space with Japanese text is given gratis. A large discount

is made for two or more insertions, and no charge is made for Japanese translations.

Three or four of our largest manufacturers are heavy purchasers of expensive space in our home magazines, but only the Kodak cameras are well advertised in Europe. A small part of the appropriation for American advertising, if expended in foreign journals, would introduce our goods abroad and lay the foundation of a valuable trade. We have many good things in the photographic line. We should let the world know it.—James W. Davidson, Consul at Tamsui.

**The Osaka Exhibition.**—Consul S. S. Lyon sends from Hiogo (Kobé), May 16, 1902, a pamphlet giving the classification of articles in the Osaka exposition, to be held from March to July, 1903.\* The pamphlet is filed in the Bureau of Foreign Commerce, where it may be examined by those interested. Mr. Lyon also transmits the following descriptive matter (printed):

"Spacious buildings, eighteen in number, are in course of erection. They are being constructed entirely of wood and covered with galvanized zinc sheets. At the northern entrance there will be a tower 90 feet high, from which visitors may view the surrounding country. Fortunately, the tower will be provided with a lift. The laying out of the grounds and construction and fitting up of the buildings and appurtenances have been undertaken by Mr. Obayashi Yoshihoro, the well-known contractor of Osaka, at the price of 1,100,000 yen (\$547,800), the building alone costing 700,000 yen (\$348,600).

"As Osaka possesses no carriages or cabs, but only jinrikisha, it was at first proposed to build a tramway to run from the Umeda Station to the exhibition, for which purpose, most of the streets being very narrow, the municipality intended to purchase and remove a great number of houses; but the expenditure for this being found too great, the idea has been abandoned. Instead, visitors who arrive at Umeda Station will be carried by train to Kawaguchi Station, which lies on the western side of the city, from which steam launches provided by the municipality will take them up the river to Minato-machi Station, and thence they will proceed by rail to the exhibition grounds."

**Alleged Shipments of Rice to the Danish West Indies.**—Consul H. W. Diederich writes from Bremen, May 17, 1902:

Having been informed that our people interested in the rice business in the United States fear that large quantities of this product were being shipped to the Danish West Indies from here, to be brought into our country free of duty, when the purchase of those islands by our government shall have become an accomplished fact, I have investigated the situation and have become satisfied that not one ounce of rice has gone from Bremen (one of the leading rice markets of the world) to the islands since January 1, 1900.

**Demand for Scales in the Transvaal.**—Consular Agent W. D. Gordon, of Johannesburg, reports that he has received a request for information in regard to automatic scales, or rather automatic registering devices which can be attached to scales used in the weighing of ore. Manufacturers are asked to write him.

**Opening for Hotel in the Azores.**—Under date of June 4, 1902, Consul G. H. Pickrell writes from St. Michaels:

I have received a letter from the local Chamber of Commerce, requesting that it be put in touch with parties who are in position to build and operate hotels. The chamber feels sure that the beauties of the island and the value of the medicinal springs have only to be put before the public to be appreciated. At the present time the hotel facilities are exceedingly limited and the great transportation lines that pass on their way to and from the United States give this as their reason for refusing to stop.

Details of the project, transmitted by the consul, have been filed in the Bureau of Foreign Commerce, where they may be consulted by those interested.

**Regulations Concerning American Shocks.**—In a report dated March 17,† relating to the increased demand for American shocks in the British lace and hosiery trades, the opinions of several importers as to the character of shock lumber required were given. As American exporters might, from those opinions, deduce the impression that miscellaneous board lengths, to be cut to box sizes here, would be admissible for export as shocks, it is well to state that such is not the case, but that the term "shocks" in paragraph 483 of the United States act of July 24, 1897, contemplates all the parts of boxes (tops, bottoms, sides and ends) ready to be put together in the condition in which exported, and does not cover lumber in lengths. Failure to comply with this requirement has, in several instances, resulted in refusal of port authorities to grant export certificates, and the shipments received here remain unavailable, to the discomfiture of importers and the demoralization of the trade.—S. C. McFarland, Consul at Nottingham.

\* For regulations, see Advance Sheets No. 1283 (March 7, 1902); Consular Reports No. 260 (May, 1902).

† Advance Sheets No. 1226 (April 2<sup>nd</sup>, 1902).

#### INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

**No. 1380. June 20.**—Co-operative Associations in Hungary—Currency in the Yukon—Localizing Foreign Shares and Bonds in Mexico—Opening for Hotel in the Azores—Wood for Port Works in Argentina—German Duty on Steel Used for Cutlery.

**No. 1381. July 1.**—Photographic Supplies in Foreign Countries—Moving Vane for Transoceanic Use.

**No. 1382. July 2.**—Trade and Industrial Conditions in Bahia.

**No. 1383. July 3.**—Wheat and Flour in Manchuria—Maltese Trade Openings—Chilean Nitrate Association—Immigration into Peru—La Rochelle—New Orleans Steam Service—New Electric Road in Canada—Russian Customs Regulations.

**No. 1384. July 5.**—Chain Boats on the River Elbe.

The Report marked with an asterisk (\*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Report by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

## SELECTED FORMULÆ.

## Furniture Polish.—

Linseed oil, raw	9 parts
Oil of turpentine	2 parts
Benzin	1 part
Wood alcohol	1 part
Ammonia water	1 part

Mix. Apply with a pad made of a bunch of cotton covered with two thicknesses of linen (an old hand-kerchief will answer). After applying rub the pad around, as in French polishing, until it begins to stick slightly, then stop. Finish off with an old piece of silk, rubbing with force. If properly applied this preparation will put a piano-finish on furniture. Both of the following are also good:

Beeswax	14 parts
Soft soap	2 parts
Turpentine	48 parts
Pearl ash	1 part
Boiling water	48 parts

Melt the wax and turpentine together; dissolve the pearl ash and soft soap in the water, mix and stir constantly until cold. This makes a cleansing and polishing paste.

Melt together 4 parts of hard paraffin and 1 part of lard and pour the mixture into a vessel containing 15 parts of hot water. Now add 12 parts of oil of turpentine, little by little, under constant stirring. Let stand until cold, then remove the pasty mass, taking care to get as little of the water as possible with it. To use either of these pastes apply with a rag, then polish with clean woolen or linen cloths.—Nat. Drug.

## Lignaole Soap.—

White soap	50 kilos
Jasmine extract	100 grammes
Oil of lignaole	200 grammes
Oil of palmarosa	120 grammes
Oil of bergamot	30 grammes
Oil of clove	20 grammes
Oil of ylang-ylang	10 grammes
Oil of cassia	5 grammes
	—Drug. Circ.

**Black Ink Powder.**—The following makes a good, serviceable black ink, on macerating the powder in 100 times its weight of rain or distilled water for a few days:

Powdered gall nuts	16 parts
Gum arabic	8 parts
Cloves	1 part
Iron sulphate	10 parts

Mix. To use: Put into an earthenware or glass vessel cover with 100 parts of rain or distilled water and set aside for 10 days or 2 weeks, giving an occasional shake the first three or four days. Decant and bottle for use.

The following is ready for use instantly on being dissolved in water:

Aleppo gall nuts	84 parts
Madder, Dutch	6 parts

Powder, mix, moisten and pack into the percolator. Extract with hot water, filter and press out. To the filtrate add 4 parts of iron acetate (or pyroacetate) and 2½ parts of tincture of indigo. Put into the water bath and evaporate to dryness and powder the dry residue. This powder may, by the addition of mucilage of gum arabic, be made into lozenges or buttons—the "ink buttons" or "ink-stones" in use abroad and much affected by travelers.—National Druggist.

## To Waterproof Cloth.—

Glue	4 ounces
Soap	2 ounces
Water	1 gallon

Soak the glue in the water till soft, then boil and dissolve the soap. Dip the cloth in the mixture, dry, and then again dip in a hot bath of

Alum	16 ounces
Water	1 gallon

## To Waterproof Shoes.—

Suet	2 ounces
Olive oil	8 ounces
Yellow wax	½ ounce
Spermaceti	½ ounce

## Patent Leather Polish.—

Yellow wax	2 ounces
Spermaceti	½ ounce
Oil of turpentine	7 ounces
Asphaltum varnish	½ ounce
Borax	60 grains
Frankfort black	½ ounce
Prussian blue	100 grains

Melt the wax and then add the borax, stirring thoroughly until an emulsion is produced. Then melt the spermaceti and stir in the varnish and turpentine previously mixed, add the wax and finally the colors.—Drug. Circ.

## Liquid Shaving Soap.—

White castile soap	5 parts
Alcohol	15 parts
Rose water	—Drug. Circ.

## Yellow Varnish for White Metals.—

Shellac	100 parts
Mastic	80 parts
Venice turpentine	75 parts
Dragon's blood	45 parts
Gamboge	50 parts
Alcohol	1500 parts

Pipeclay	8 ounces
Orris root	4 ounces
Soap	1 ounce
Borax	2 ounces
Ammonium chloride	4 drachms

Wipe the gloves with a damp cloth, and then apply the powder with slight friction. Dry and brush off.—Drug. Circ.

## VALUABLE BOOKS

## COMPRESSED AIR,

Its Production, Uses and Applications.  
By GARDNER D. HISCOX, M.E. Author of "Mechanical Movements, Powers, Devices, etc., etc."

Large 8vo., 620 pages, 545 illustrations. Price, \$5 in cloth, \$6.50 in half morocco.

A complete treatise on the subject of Compressed Air, comprising its properties, production, uses and its applications in its thermodynamics, compression, transmission, expansion, and power purposes in mining and engineering work; pneumatic motors, shop tools, air blasts for cleaning and painting. The Sand Blast, air lifts, pumping of water, acids and oils; aeration and purification of water supplies, and many other applications. A practical treatise on the transmission, refrigeration, The Air Brake, and numerous appliances for work with air tables of compression, expansion and physical properties. This is a most comprehensive work on the subject of Compressed Air, giving both the theory and application.

Large 8vo., 620 pages, 545 illustrations. Price, \$5 in cloth, \$6.50 in half morocco.

Those who already have the Cyclopedias may obtain the 1901 APPENDIX. Price, bound in cloth, \$1 postpaid.

## SIXTEENTH REVISED AND ENLARGED EDITION OF 1901

## THE SCIENTIFIC AMERICAN

## Cyclopedias of Receipts, Notes and Queries

## 15,000 RECEIPTS. 734 PAGES

Price, \$5 in Cloth; \$6 in Sheep; \$6.50 in Half Morocco, postpaid.

This work has been revised and enlarged. 900 New Formulas. Those who have it are arranged so as to be of use to only the specialist, but to the general reader, it should have a place in every home and workshop. A circular containing full Table of Contents will be sent on application.

Those who already have the Cyclopedias may obtain the 1901 APPENDIX. Price, bound in cloth, \$1 postpaid.

## The Progress of Invention in the Nineteenth Century.

By EDWARD W. BYRN, A.M.

Large Octavo, 480 Pages, 300 Illustrations. Price, \$5 by Mail, Postpaid.

The most important book ever published on invention and discovery. It is as readable as a novel, being written in popular style.

The book gives a most comprehensive and coherent account of the progress which distinguishes this as the "golden age of invention," resulting in industrial and commercial development which is without precedent. A chronological calendar of the leading inventions of the century, most important from the point of view of the reader, is given at a glance to important inventions and discoveries of any particular year. The book is printed with large type, on fine paper, and is elaborately illustrated with 300 engravings and is attractively bound.

## SCIENTIFIC AMERICAN BUILDING MONTHLY.

Bound volumes contain many illustrations from photographs of the latest modern Dwellings in various sections of the country, showing the best examples of interior and exterior architecture. Price \$2 per volume, covering a period of six months. The yearly subscription is \$2.50. Single copies, 25 cents. The May, 1902, issue contains illustrations of Gardens and Porches of interest and value.

## MAGIC

## Stage Illusions and Scientific Diversions, including Trick Photography.

By A. A. HOPKINS.

The work appeals to old and young alike, and it is one of the most attractive holiday books of the year. The illusions are illustrated by the highest class of engravings, and the expose of the tricks are, in many cases, furnished in a frank and candid manner, leaving nothing to the imagination. The book gives a full account of the latest in stage magic, fire-eating, sword swallowing, ventriloquism, mental magic, ancient magic, automata, curious toys, stage effects, photographic tricks, and the projection of moving photographs are all well described and illustrated, making a handsome volume. It is tastefully printed and bound. Acknowledged by the profession to be the Standard Work on Magic. 560 pages, 430 illustrations. Price \$2.50.

## A COMPLETE ELECTRICAL LIBRARY.

By Prof. T. O'CONOR SLOANE.

An inexpensive library of the best books on Electricity. Put up in a neat folding box. For the student, the amateur, the workshop, the electrical engineer, school and college. Comprising five books as follows:

Arithmetical of Electricity, 128 pages. \$1.00

Electric Power Making, 160 pages. \$1.00

How to Become a Successful Electrician, 160 pages. \$1.00

Standard Electrical Dictionary, 620 pages. \$3.00

Electricity Simplified, 156 pages. \$1.00

Electric Power Plants, and over 600 illustrations. \$1.00

A valuable and indispensable addition to every library.

Our Great Special Offer.—We will send prepaid the above five volumes, handsomely bound in blue cloth, with silver lettering, and inclosed in a neat folding box, at the **Special Reduced Price of \$5.00** for the complete set. The regular price of the five volumes is \$7.50.

The book is up to date and very fully illustrated with various types of Horseless Carriages, Automobiles and Motor Cycles, with details of the same. Large 8vo. About 450 pages. Very fully illustrated. Price \$3.00, postpaid.

AN AMERICAN BOOK ON

## Horseless Vehicles, Automobiles and Motor Cycles.

OPERATED BY

Steam, Hydro-Carbon, Electric and Pneumatic Motors.

By GARDNER D. HISCOX, M.E.

This work is written on a broad basis, and comprises in its scope a full illustrated description with details of the progress and manufacturing advances of one of the most important innovations of the times, contributing to the pleasure and business convenience of mankind.

The first come directions for making the patterns; this is followed by the details of the mechanical operations of finishing up and fitting the castings. It is profusely illustrated with beautiful engravings of the actual work in progress, showing the modes of chiseling, turning, boring and planing, the use of lathes, and also plainly showing the fitting up and erection of the engine.

Dimensioned working drawings give clearly the sizes and forms of the various details.

The entire engine, with the exception of the fly-wheels, is designed to be made on simple machines, with slide rests.

The book closes with a chapter on American practice in Gas Engine design and gives simple rules so that anyone can figure out the dimensions of similar engines of other powers.

Every illustration in this book is new and original, having been made especially for this work.

Large 8vo., 600 pages. 1,649 illustrations. Price \$3.

MECHANICAL MOVEMENTS,  
Powers, Devices, and Appliances.

By GARDNER D. HISCOX, M.E.

A Dictionary of Mechanical Movements, Powers, Devices and Appliances, embracing an illustrated description of the greatest variety of mechanical movements and devices in any language. A new work on illustrated mechanics, mechanical movements, devices and appliances, covering nearly the whole range of the practical and inventive field, for the engineer, manufacturer, inventor, inventress, engineer, draughtsman, student and all others interested in any way in the devising and operation of mechanical works of any kind.

Large 8vo., 600 pages. 1,649 illustrations. Price \$3.

Large

